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Yours faithfully
Thos Henry Yabbicom

THOS. HENRY YABBICOM, M. INST. C.E.
PAST PRESIDENT.

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INDEXED

PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXIX. 1902-1903

EDITED BY,

THOMAS COLE

ASSOC. M. INST. C.E.

(*Secretary of the Association*)

The Association is not as a body responsible for the facts and opinions advanced herein.

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LIST OF OFFICERS, 1903–1904.

COUNCIL.

President.—W. WEAVER, M. Inst. C.E., Kensington.

Vice-Presidents.

J. PATTEN BARBER, M. Inst. C.E., Borough Engineer, Islington.
A. T. DAVIS, Assoc. M. Inst. C.E., County Surveyor, Salop.
A. E. COLLINS, M. Inst. C.E., City Engineer, Norwich.

Ordinary Members of Council.

W. N. BLAIR, M. Inst. C.E., Borough Surveyor, St. Pancras.
J. W. BRADLEY, M. Inst. C.E., City Engineer, Westminster.
J. A. BRODIE, M. Inst. C.E., City Engineer, Liverpool.
C. H. COOPER, M. Inst. C.E., Surveyor to the Urban District Council, Wimbledon.
A. CREER, Assoc. M. Inst. C.E., City Surveyor, York.
A. D. GREATOREX, Assoc. M. Inst. C.E., Borough Surveyor, West Bromwich.
E. P. HOOLEY, Assoc. M. Inst. C.E., County Surveyor, Nottingham.
E. J. LOVEGROVE, M. Inst. C.E., Engineer to the Urban District Council, Hornsey, N.
F. J. C. MAY, M. Inst. C.E., Borough Engineer, Brighton.
J. PATON, Borough Engineer, Plymouth.
J. S. PICKERING, Assoc. M. Inst. C.E., Borough Engineer, Cheltenham.
S. S. PLATT, M. Inst. C.E., Borough Surveyor, Rochdale.
J. PRICE, M. Inst. C.E., City Surveyor, Birmingham.
H. T. WAKELAM, M. Inst. C.E., County Surveyor, Middlesex.
C. F. WIKE, M. Inst. C.E., City Surveyor, Sheffield.

Past Presidents.

C. H. LOWE, M. Inst. C.E., 30 Somerset Street, Portman Square, W.
E. G. MAWBEY, M. Inst. C.E., Borough Engineer, Leicester.
T. H. YABBICOM, M. Inst. C.E., City Engineer, Bristol.

Elective Past Presidents.

J. LOBLEY, M. Inst. C.E., Borough Engineer, Hanley.
O. C. ROBSON, M. Inst. C.E., Surveyor to the Urban District Council, Willesden, N.W.
W. HARPUR, M. Inst. C.E., Borough Engineer, Cardiff.

Honorary District Secretaries.

Eastern District.—J. W. COCKRILL, M. Inst. C.E., Great Yarmouth.
Home District.—R. J. THOMAS, M. Inst. C.E., Aylesbury.
Irish District.—R. H. DORMAN, M. Inst. C.E., Armagh.
Lancashire and Cheshire District.—C. BROWNRIDGE, Assoc. M. Inst. C.E., Birkenhead.
Metropolitan District.—J. R. DIXON, Assoc. M. Inst. C.E., Shoreditch.
Midland District.—H. RICHARDSON, Assoc. M. Inst. C.E., Handsworth.
Northern District.—J. P. DALTON, Ryton-on-Tyne.
Scottish District.—W. DYACK, M. Inst. C.E., Aberdeen.
Wales (North).—J. W. M. SMITH, Wrexham.
„ (South).—W. E. C. THOMAS, Assoc. M. Inst. C.E., Neath.
Western District.—J. S. PICKERING, Assoc. M. Inst. C.E., Cheltenham.
Yorkshire District.—W. H. HOPKINSON, Assoc. M. Inst. C.E., Keighley.

General Hon. Secretary.

CHAS. JONES, M. Inst. C.E.

Honorary Treasurer.

LEWIS ANGELL, M. Inst. C.E.

Secretary.

THOMAS COLE, Assoc. M. Inst. C.E., 11 Victoria Street, London, S.W.

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PAST PRESIDENTS.

1873–4 1874–5	LEWIS ANGELL, M. Inst. C.E.
1875–6.	*J. G. LYNDE, M. Inst. C.E.
1876–7.	JAMES LEMON, M. Inst. C.E.
1877–8.	*F. ASHMEAD, M. Inst. C.E.
1878–9.	G. F. DEACON, M. Inst. C.E.
1879–80.	*E. PRITCHARD, M. Inst. C.E.
1880–1.	*A. W. MORANT, M. Inst. C.E.
1881–2.	*W. S. TILL, M. Inst. C.E.
1882–3.	C. JONES, M. Inst. C.E.
1883–4.	W. H. WHITE, M. Inst. C.E.
1884–5.	W. G. LAWS, M. Inst. C.E.
1885–6.	*R. VAWSER, M. Inst. C.E.
1886–7.	J. LOBLEY, M. Inst. C.E.
1887–8.	*J. GORDON, M. Inst. C.E.
1888–9.	E. B. ELLICE-CLARK, M. Inst. C.E.
1889–90 1890–91	H. P. BOULNOIS, M. Inst. C.E.
1891–2.	T. DE C. MEADE, M. Inst. C.E.
1892–3.	J. CARTWRIGHT, M. Inst. C.E.
1893–4.	J. T. EAYRS, M. Inst. C.E.
1894–5.	A. M. FOWLER, M. Inst. C.E.
1895–6.	E. R. S. ESCOTT, M. Inst. C.E.
1896–7.	F. J. C. MAY, M. Inst. C.E.
1897–8.	Sir ALEX. R. BINNIE, M. Inst. C.E.
1898–9.	O. C. ROBSON, M. Inst. C.E.
1899–00.	W. HARPUR, M. Inst. C.E.
1900–01.	C. H. LOWE, M. Inst. C.E.
1901–02.	E. GEORGE MAWBEY, M. Inst. C.E.
1902–03.	T. H. YABBICOM, M. Inst. C.E.

* Deceased.

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LIST OF MEMBERS.

IT IS PARTICULARLY REQUESTED THAT EVERY CHANGE OF ADDRESS MAY BE COMMUNICATED WITHOUT DELAY TO THE SECRETARY.

* *Those Members against whose names a star is placed have obtained the Certificate of the Association.*

R *signifies re-election under Bye-law 5a.* G *elected as Graduate.* A *elected as Associate.* TA *transferred to Associate class.* T *transferred to Member.*

HONORARY MEMBERS.

Date of Election and Transfer.		
1897 Oct. 16	BECHMANN, G.	Ingénieur en chef des Ponts et Chaussées, Paris.
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1901 Mar. 23	HASSELT, J. VAN	Director of Public Works, Amsterdam.
1886 June 12	MANSERGH, JAS., M. Inst. C.E.	5 Victoria Street, Westminster, S.W.
1892 Apr. 23	PUTZEYS, E.	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, HY., M. Inst. C.E.	Parliament Mansions, Westminster, S.W.
1874 June 1	TULLOCH, MAJOR H., R.E.	28 Victoria Street, S.W.

MEMBERS.

1893 Oct. 21	ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21 R1902 Mar. 22	ABURROW, C., M. Inst. C.E...	31/32 Bettelheim Buildings, Johannesburg, S.A.
1903 May 16	ADAMS, A. E...	Borough Engineer, Chippenham, Wilts.
1893 Jan. 14	ADSHEAD, E. E.	Borough Surveyor, Macclesfield.
1896 Jan. 18	AITKEN, T., A.M. Inst. C.E.	County Surveyor, Cupar, Fife.
1897 Jan. 16	ALLEN, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1873 May 2 R1884 Jan. 26	*ALLEN, T. T...	Broad Street, Stratford-on-Avon.
1897 June 19	ALVES, G.	Surveyor to the Urban District Council, Glastonbury.
1890 June 26	ANDERSON, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
1900 Dec. 15	ANDERSON, W. V., Assoc. M. Inst. C.E.	City Surveyor, Winchester.
G1898 June 30 T1899 Oct. 21	*ANDREWS, S. P.	Surveyor to the Urban District Council, Caversham.

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Date of Election and Transfer.			
g1894 Oct. 20 T1899 Oct. 21	*ANGEL, R. J., A. M. Inst. C.E.	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*ANGELL, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1873 Feb. 15	ANGELL, LEWIS, M. Inst. C.E. (*Past President, and Hon. Treasurer.*)	"Calside," Carlisle Road, Eastbourne.
1899 June 29	ANSTEE, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	ARMISTEAD, R., Assoc. M. Inst. C.E.	8 Charles Street, Bradford.
1900 June 16	ASQUITH, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	ATKINSON, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
1897 Feb. 13	BAFF, C. J.	Surveyor to the Urban District Council, Gosforth, Newcastle-on-Tyne.
1900 Feb. 10	BAINS, G.	Surveyor to the Urban District Council, Saltburn-by-the-Sea.
1884 May 29	BAKER, F.	Borough Surveyor, Middlesbrough, Yorks.
1891 Aug. 1 R1903 Feb. 21	BAKER, J., A.M. Inst. C.E. ..	75 High Street, Slough.
1896 June 25	BALDWIN, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
g1891 Aug. 1 T1896 Feb. 22	*BALL, B., A.M. Inst. C.E. ..	Borough Surveyor, Nelson, Lancs.
g1887 Sept. 17 T1898 Feb. 19	*BALL, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
1879 Oct. 23	BANKS, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1887 Mar. 12	BARBER, J. Patten, M. Inst. C.E. (*Vice-President.*)	Borough Engineer, Islington, N.
1903 June 25	BARCLAY, J.	Surveyor to the Urban District Council, Chiswick.
g1888 Sept. 15 T1892 July 11	*BARNES, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1890 May 3	BARRAS, C. C.	Surveyor to the Rural District Council, Doncaster.
1890 Feb. 1	BARRATT, F. W.	Late Borough Surveyor, Bethnal Green, N.E.
1897 Jan. 16	BARRETT, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1899 Jan. 21	BARRS, J. D.	Surveyor to the Urban District Council, Bromyard.
1898 Jan. 15	BARTON, J. I.	Surveyor to the Urban District Council, St. Helens, Isle of Wight.
1896 Oct. 24	BAYLIS, T. P., Assoc. M. Inst. C.E.	Borough Surveyor, Droitwich.
g1901 June. 8 T1903 July 25	*BEACHAM, W. E.	Town Surveyor, Leek.
1903 May 16	BEAN, J. A.	County Surveyor, Northumberland. Moot Hall, Newcastle.
1891 Sept. 12	BEATSON, W.	Borough Surveyor, Leith.

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Date of Election and Transfer.		
1894 Jan. 13	BEAUMONT, A.	County Surveyor, Yorks, East Riding. County Hall, Beverley.
1897 Mar. 13	BEAUMONT, G. E.	Surveyor to the Rural District Council, Wortley. "Holme Lea," Greenoside, near Sheffield.
1897 Mar. 13	BEAUMONT, T. C.	Surveyor to the Rural District Council, Driffield.
1892 Jan. 16	BELL, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
1897 Jan. 16	BELL, G. J., Assoc. M. Inst. C.E.	County Surveyor, Cumberland.
1895 Jan. 19	BELLINGHAM, A. W. H., Assoc. M. Inst. C.E.	Municipal Engineer, Tientsin, China.
1896 Jan. 18	BENNETT, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1886 Dec. 18 R1902 Nov. 8	BENNETT, W. B. G., Assoc. M. Inst. C.E.	Midland Bank Chambers, Southampton.
G1898 Dec. 17 T1900 July 19	*BENNETTS, J. P.	Surveyor to the Urban District Council, Harrow.
1886 Oct. 16 R1896 Jan. 18	BERRINGTON, R. E. W., Assoc. M. Inst. C.E.	Graisley, Wolverhampton.
1892 Mar. 11 R1899 May 6	BESWICK, W. H., Assoc. M. Inst. C.E.	214 Astley Street, Dukinfield, Cheshire.
1891 June 6	BETTANY, F.	Borough Engineer, Burslem.
1902 Mar. 22	BIBBEY, T.	Surveyor to the Urban District Council, Audley, Staffs.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	9 Gt. George Street, Westminster, S.W.
1896 Nov. 28	BIRD, W. F.	Surveyor to the Urban District Council, Midsomer Norton.
1897 Jan. 16	BIRKS, E.	Highway Surveyor to Rural District Council, Uxbridge.
1891 June 25	BISHOP, McW.	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1901 Feb. 16	BLACKBURN, J.	Surveyor to the Urban District Council, Soothill Upper.
1873 May 2	BLACKSHAW, W., Assoc. M. Inst. C.E.	Borough Surveyor, Stafford.
1886 June 12	BLAIR, W. N., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, St. Pancras.
1903 Oct. 17	BLAND, J. D.	Surveyor to the Urban District Council, Chesterton.
1900 Mar. 10	BLOOD, A. T.	Surveyor to the Urban District Council, Hitchin.
1895 Oct. 19	BODEN, E. G.	Surveyor to the Rural District Council, Romford.
1902 Nov. 8	BORG, E. A.	Borough Surveyor, Margate.
G1898 June 30 TA1901 Dec. 7 T1903 Mar. 21	*BOWE, D. J.	Borough Engineer, Eastbourne.
1895 Jan. 19 R1903 Feb. 21	BOTTERILL, C., A.M.Inst.C.E.	583 Fulham Road, Walham Green, S.W.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	44 Campden House Court, Kensington, W.
1898 Mar. 19 R1903 Feb. 21	BOWEN, H. W.	The Brambles, Hayward's Heath.
1898 Feb. 19	BOWLES, A. R., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sandgate.

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Date of Election and Transfer.		
1898 Oct. 15	BOYLE, J. C., A. M. Inst. C.E.	City Surveyor, Armagh.
1894 Oct. 20	BRADFORD, J. H.	Surveyor to the Urban District Council, Aylesbury.
1903 May 16	BRADLEY, A. W., A.M. Inst. C.E.	Borough Engineer, Bury, Lancs.
G1889 May 18 T1893 Apr. 22	*BRADLEY, J. W., Assoc. M. Inst. C.E. (*Member of Council.*)	City Engineer, Westminster, S.W.
1897 Jan. 16	BRADLEY, W. L.	Surveyor to the Urban District Council, Tonbridge.
G1894 Jan. 13 T1896 Oct. 24	*BRADSHAW, F. E. G.	Borough Surveyor, Tamworth.
1873 May 2	BRESSEY, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
1891 Aug. 1	BRETT, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	BRETTELL, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	BRIDGES, O. A.	Surveyor to the Urban District Council, Bognor.
1891 Mar. 21	BRIERLEY, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1901 Dec. 7	BRODIE, J. A., M. Inst. C.E. (*Member of Council.*)	City Engineer, Liverpool.
1889 Apr. 13	BRODIE, J. S., A.M. Inst. C.E.	Borough Engineer, Blackpool.
1894 Oct. 20	BROOKE, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
1885 Feb. 7 R1892 Apr. 23	BROOKE, W., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Strood. "Lympstone," Goddington Road, Rochester.
1891 Feb. 21	BROOM, G. J. C., M.Inst. C.E.	Borough Engineer, St. Helen's, Lancashire.
1884 July 10	BROWN, A., M. Inst. C.E. ..	Borough Engineer, Nottingham.
1898 Jan. 15	BROWN, C., A. M. Inst. C.E...	Surveyor to the Urban District Council, Bedlingtonshire.
1881 Jun. 18	BROWN, J. W., M. Inst. C.E.	Borough Engineer, West Hartlepool.
G1894 July 7 T1898 Sept. 3	*BROWN, R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Southall Norwood.
1889 Feb. 9 R1898 Jan. 15	*BROWN, R. R.	Electrical Engineer to the Urban District Council, Bridlington.
1893 Mar. 4	*BROWNRIDGE, C., A. M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Birkenhead. *Hon. Secretary*, Lancashire and Cheshire District.
1901 Feb. 16	BRYCE, J., A.M. Inst. C.E.	Burgh Surveyor, Partick, N.B.
G1889 Feb. 9 T1902 Mar. 22	*BRYNING, W. G.	County Surveyor, Northallerton, Yorks.
1873 May 2	BUCKHAM, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
1897 July 8 R1902 Mar. 22	BUCKLEY, M. J., Assoc. M. Inst. C.E.	26 Bessborough Terrace, N.C.R., Dublin.
1897 Feb. 13	BULL, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
1895 Feb. 16	BUNTING, T. F.	Borough Surveyor, Maidstone.
1895 Jan. 19	BURDEN, A. M., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
1892 Sept. 24	BURGESS, S. E., M. Inst. C.E.	Borough Engineer, South Shields.

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Date of Election and Transfer.		
1890 June 7	BUBSLAM, B.	Borough Surveyor, Congleton.
G1895 Jan. 19 T1902 Jan. 25	*BURTON, A., A.M. Inst. C.E.	Borough Engineer, Stoke-on-Trent.
1897 Jan. 16	BUSBRIDGE, T. A.	Surveyor to the Rural District Council, Spilsby.
1890 Sept. 13	BUTLER, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	BUTTERWORTH, A. S., Assoc. M. Inst. C. E.	Municipal Engineer, Port Elizabeth, S. Africa.
1894 Apr. 6	CAINE, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
1891 Dec. 12 R1903 Jan. 17	CAIRNCROSS, T. W., Assoc. M. Inst. C.E.	Frasers Buildings, Long Market, Long Street, Cape Town, S. Africa.
1903 Jan. 17	CALDER, W.	City Engineer, Prahran, Victoria.
1895 July 27	CALVERT, W.	Surveyor to the Urban District Council, Hebden Bridge.
1894 June 21	CAMERON, D.	7 & 8 Bedford Circus, Exeter.
1891 Oct. 17	CAMPBELL. A. H., Assoc. M. Inst. C.E.	Engineer and Surveyor, Town Hall, East Ham, E.
1887 Mar. 12	CAMPBELL, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
1888 May 12	CAPON, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 R1899 Jan. 21	CARD, H...	North Street, Lewes.
1891 June 25 R1902 Feb. 22	CARLINE, J., A. M. Inst. C.E.	"Merivale," Catford Hill, S.E.
1903 Feb. 21	CARTER, A. H.	Surveyor to the Urban District Council, Litherland, Liverpool.
1901 June 27	CARTER, G. E.	Surveyor to the Rural District Council, Winchester.
1897 June 19	CARTER, G. F., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mexborough.
1898 Dec. 17	CARTWRIGHT, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.
1900 May 19	CARTWRIGHT, F.	Late Municipal Engineer, Howrah, Bengal.
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	Peel Chambers, Market Place, Bury.
1895 Mar. 16	CASS, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
1895 Mar. 16 R1899 Feb. 25	CATT, A. J.	"Laurel Dene," Kingston-by-Sea, near Brighton.
1896 Mar. 21	CHADWICK, J...	Surveyor to the Urban District Council, Fenny Stratford.
1903 Jan. 17	CHAMBERS, S. H.	Surveyor to the Urban District Council, Hampton.
1901 Dec. 7	CHANCELLOR, W. B.	Surveyor to the Urban District Council, Brownhills, Staffs.
1897 Jan. 16	CHAPMAN, C. R. W.	Surveyor to the Urban District Council, Wembley.
1893 Mar. 4 R1899 May 6	CHARLES, T.	Peterborough Road, Harrow.

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Date of Election and Transfer.		
1884 Dec. 20	CHART, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1900 Feb. 10	CHOWINS, W. H.	Surveyor to the Urban District Council, Lynton.
1884 Oct. 9	CLARE, J., A.M. Inst. C.E..	Surveyor to the Urban District Council, Sleaford.
1898 Sept. 3	CLARK, E. O'N.	County Surveyor, Leitrim.
1899 Oct. 21	CLARKE, H. A.	Surveyor to the Urban District Council, Briton Ferry.
1898 Oct. 15	CLARRY, W. H., A. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
1886 Dec. 18	CLARSON, H. J.	Surveyor to the Rural District Council, Tamworth.
1901 May 11	CLAYTON, F. T.	Borough Engineer, Reigate.
1893 July 31	CLOUGH, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21	CLUCAS, R. H.	Borough Surveyor, Kendal.
G1894 July 7 T1896 Oct. 24	*COALES, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
G1886 Oct. 16 T1888 July 12	*COALES, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30	COCKRILL, J. W., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth; *Hon. Secretary*, Eastern District.
1893 June 24	COCKRILL, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1892 Sept. 24	COLLEN, W. M.A., M.Inst.C.E.	County Surveyor, Dublin. 9 Hume Street, Dublin.
1897 July 31	COLLINGWOOD, T. A.	Surveyor to the Urban District Council, Itchen, Woolston, Southampton.
1888 May 12	COLLINS, A. E., M. Inst. C.E. (*Vice-President.*)	City Engineer, Norwich.
1900 Oct. 15 R1901 June 27	COLLINS, G. M.	Town Hall, Withington, Manchester.
1896 Jan. 18	COLLINS, R.	Surveyor to the Urban District Council, Enfield, N.
1886 May 1 R1897 Feb. 13	COMBER, P. F., M. Inst. C.E.	Town Surveyor, Bray. 19 Lower Leeson Street, Dublin.
G1897 July 31 T1900 Dec. 15	*COOK, F. C.	Surveyor to the Urban District Council, Nuneaton.
1893 Apr. 22	COOK, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
G1888 July 12 T1890 Mar. 29	*COOK, J., Assoc. M. Inst. C.E.	Borough Engineer, Cape Town, S. Africa.
1894 Mar. 3	COOKE, E.	Surveyor, Abersychan, Pontypool.
G1888 July 12 T1890 Mar. 29	*COOPER, C. H., M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Wimbledon.
1898 Sept. 3	COOPER, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20	COOPER, F. A., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17	COOPER, W. W.	Surveyor to the Urban District Council, Slough.

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Date of Election and Transfer.		
1893 Apr. 22 R1902 Nov. 8	COPLEY, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Nov. 28	CORBETT, J.	Borough Engineer, Salford.
1896 Jan. 18	CORDON, R. C.	Surveyor to the Rural District Council, Belper. Hazelwood, Derby.
G1896 May 29 T1897 Jun. 19	*CORRIE, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 Jun. 21 R1903 Jan. 17	COTTERELL, A. P. I., Assoc. M. Inst. C.E.	28 Baldwin Street, Bristol; and 17 Victoria Street, S.W.
1891 Jun. 25 R1897 July 31	COVERLEY, J. S.	Surveyor, Penmaenmawr.
1898 May 21	COX, J.	Surveyor to the Urban District Council, Margam, Port Talbot.
1880 Feb. 7	COX, J. H., M. Inst. C.E. ..	City Surveyor, Bradford.
1900 Mar. 10	CRABTREE, W., A.M.Inst. C.E.	Highway Surveyor to the Rural District Council, Doncaster.
1887 Dec. 10	CRABTREE, W. H. R., M. Inst. C.E.	Borough Surveyor, Doncaster.
1881 May 6	CREER, A., Assoc. M. Inst.C.E. (*Member of Council.*)	City Surveyor, York.
1900 July 19	CROSS, A. W., A. M. Inst. C.E.	Surveyor to the Urban District Council, King's Norton.
1889 Dec. 14	*CROWTHER, J. A., Assoc. M. Inst. C.E.	Borough Engineer, Southampton.
G1900 Jan. 19 T1903 May 16	*CRUMP, E. H.	Surveyor to the Urban District Council, Hinckley.
1900 Jun. 16	CUMMING, W.	Highway Surveyor to the Rural District Council, Lanchester, co. Durham.
1889 Dec. 14	CURRALL, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1896 Apr. 25	CURRY, W. F.	P.W.D., Volksrust, South Africa.
1893 Mar. 4 R1899 Feb. 25	CURRY, W. T., A. M. Inst.C.E.	"Beverley," Stroud Road, Gloucester.
1897 Feb. 13	CUTLER, H. A., A.M.Inst.C.E.	City Surveyor, Belfast.
1893 Jun. 24	*DALTON, J. P. .. .. .. (*Member of Council.*)	Surveyor to the Urban District Council, Ryton-on-Tyne; *Hon. Secretary*, Northern District.
1899 Jan. 21	DAVIDSON, J. F.	Surveyor to the Urban District Council, Willington Quay.
1900 Oct. 15	DAVIES, W. J.	Surveyor to the Urban District Council, Nantyglo and Blaina. Council Offices, Blaina.
1880 Apr. 10	DAVIS, A. T., Assoc. M. Inst. C.E. (*Vice-President.*)	County Surveyor, Salop.
1900 Oct. 15	DAWSON, C. F.	Surveyor to the Urban District Council, Barking.
1884 Apr. 19 R1902 Nov. 8	DAWSON, C. J.	Wykeham House, Barking.
1896 July 25	DAWSON, N. H.	Borough Surveyor, Banbury.
1879 May 1	DAWSON, W., M. Inst. C.E.	Surveyor to the Urban District Council, Leyton, N.E..

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Date of Election and Transfer.		
1898 Jan. 15	DAY, C.	Borough Surveyor, Chatham.
1873 Dec. 9	DEACON, G. F., M. Inst. C.E. (*Past President.*)	16 Great George Street, Westminster, S.W.
1898 Jan. 15	DEANE, J.	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*DEARDEN, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
1895 Oct. 19	DEBNAM, A. W.	Mount Pleasant, Plymouth.
1890 Feb. 1	DENNIS, N. F., A.M.Inst.C.E.	Surveyor to the Urban District Council, Aldershot.
1880 May 27 R1903 Feb. 21	DENT, W.	Railway Street, Nelson, Lancashire.
1890 Sept. 13	DEVERELL, T. C., Assoc. M. Inst. C.E.	City Engineer, Calcutta.
1896 July 25	DEWHIRST, J...	Surveyor to the Rural District Council, Chelmsford.
G1898 Oct. 15 T1899 Jun. 10	*DICKINSON, A. J.	Surveyor to the Rural District Council, Long Crendon, Thame, Oxon.
1895 June 27	DICKINSON, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.
1890 Sept. 13 R1896 Jan. 18	DICKINSON, T. R., Assoc. M. Inst. C.E.	Burton House, Clifton, York.
1900 Feb. 10	DIGGLE, JAMES	Surveyor to the Urban District Council, Matlock.
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1889 Sept. 21	DIGGLE, WM.	Surveyor to the Rural District Council, Runcorn. Frodsham, Chester.
1877 Oct. 20	DITCHAM, H.	Borough Surveyor, Harwich.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Desborough.
1897 Jan. 16 R1903 Jan. 17	DIXON, F. J., A.M. Inst. C.E.	5 Prospect Crescent, Harrogate.
G1891 Aug. 1 T1896 Oct. 24	*DIXON, J. R., A.M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Shoreditch. *Hon. Secretary*, Metropolitan District.
1887 June 18	DIXON, R., Assoc.M.Inst.C.E.	Borough Surveyor, Stratford-on-Avon.
1889 July 4	DODD, P., Assoc. M. Inst.C.E.	Borough Surveyor, Western District, Wandsworth, S.W.
1897 Jan. 16	*DODGEON, A.	Surveyor to the Urban District Council, Clayton-le-Moors.
1888 May 12	DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
1899 Oct. 21	DRYLAND, A., A. M. Inst. C.E.	County Surveyor, Hereford.
1891 Dec. 12	DUFFIN, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15 R1901 June 8	DUNCH, T. H.	59 Darnley Road, Gravesend.
1898 May 21	DUNN, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
1873 Feb. 15	DUNSCOMBE, C., M.A., M. Inst. C.E.	92 Victoria Street, Westminster, S.W.
G1891 Jan. 21 T1892 Sept. 24	*DYACK, W., M. Inst. C.E. (*Member of Council.*)	Burgh Surveyor, Aberdeen; *Hon. Secretary*, Scottish District.

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Date of Election and Transfer.		
1882 June 29	DYER, S.	Engineer to the Rural District Council, Bridlington.
1879 May 1	EARNSHAW, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1900 May 19 R1901 Dec. 7	*EASTWOOD, J.	Town Hall, Halifax.
1883 Aug. 4	EATON-SHORE, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
1877 Nov. 18	EAYRS, J. T., M. Inst. C.E. (*Past President.*)	39 Corporation Street, Birmingham.
1890 May 3	EBBETTS, D. J.	Surveyor to the Urban District Council, Acton.
1890 Feb. 1	EDDOWES, W. C.	Borough Surveyor, Shrewsbury.
1891 Jan. 21 R1896 Jan. 18	*EDGE, F. J., A. M. Inst. C.E.	City Engineer, Newcastle-on-Tyne.
1888 May 12	EDINGER, P.	Surveyor to the Urban District Council, Frome.
1891 Sept. 12	EDMONDSON, S.	Surveyor to the Rural District Council, Burnley.
1899 Mar. 25	EDWARDS, J. V.	County Surveyor, West Riding, Yorkshire. Wakefield.
1898 Apr. 23	EDWARDS, T. L.	County Surveyor Glamorgan. Bridgend, Glam.
1897 July 31	*ELFORD, E. J.	Borough Surveyor, Southend-on-Sea.
1885 Oct. 8	ELFORD, J.	Borough Surveyor, Poole.
1873 Feb. 15	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	13 Charles Street, St. James's, London, S.W.
1900 Apr. 21	ELLIOTT, F. T.	Surveyor to the Rural District Council, Isle of Thanet. Birchington-on-Sea.
1893 Oct. 21 R1901 Feb. 16	ELLIS, R. E., M. Inst. C.E. ..	70–72 Chancery Lane, W.C.
1895 July 27	ENTWISLE, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
1873 May 2	ESCOTT, E. R. S., M. Inst. C.E. (*Past President.*)	16 Clifton Road, Halifax.
1896 June 25	EVANS, A. J. L.	Borough Surveyor, Luton.
1897 Jan. 16	EVANS, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
1895 Jan. 19	EVANS, E. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, S. Wales.
1896 May 29	EVANS, J. P.	Surveyor to the Rural District Council, Wrexham.
1903 Oct. 17	EVANS, S.	County Surveyor, Mold, Flintshire.
1890 June 7	FAIRLEY, W., A.M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W., and 69 Victoria Street, S.W.
G1898 June 30 T1899 Feb. 25	*FARNHAM, W. A.	Surveyor to the Urban District Council, Foots Cray.
1887 July 14	FARRALL, T.	Surveyor to Urban District Council, Sherborne, Dorset.
1893 July 31	FARRINGTON, T. B., A. M. Inst. C.E.	Surveyor to the Rural District Council, Conway. Trinity Square, Llandudno.

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Date of Election and Transfer.		
1896 Jan. 18	FARRINGTON, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1896 Nov. 28	FEATHER, F.	Surveyor to the Urban District Council, Chepstow.
1900 Dec. 15	FELLOWS, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 13	FENN, T...	Surveyor to the Urban District Council, Belper.
1887 Sept. 17 R1899 June 10	FIDDIAN, W.	Engineer to Stourbridge and Stour Valley Sewerage Boards. Old Bank Offices, Stourbridge.
1899 Jan. 21	FIDLER, A., A. M. Inst. C.E.	Borough Engineer, Northampton.
1894 Jan. 13	FINDLAY, R., A.M. Inst. C.E.	Surveyor, Eltham Green, S.E.
1903 May 16	*FINGLAH, F. J.	Borough Engineer, Carmarthen.
1903 Oct. 17	FISHER, S.E.	Surveyor to the Urban District Council, Felixstowe.
G1892 May 28 T1897 Jan. 16 R1903 July 25	*FITTON, G.	Thornfield, Urmston Lane, Stretford, Manchester.
1903 May 16	FITZMAURICE, M., C.M.G., M. Inst. C.E.	Chief Engineer, London County Council, Spring Gardens.
1895 Oct. 19	FLEMING, M. J.	Borough Surveyor, Town Hall, Waterford.
1893 Jan. 14 R1899 May 6	FLOWER, T. J. M., Assoc. M. Inst. C.E.	Scottish Buildings, Baldwin Street, Bristol; and 28 Victoria Street, Westminster, S.W.
G1895 July 27 T1899 Jan. 21	*FORBES, A. H.	Surveyor to the Urban District Council, Saffron Walden.
1896 Nov. 28	FORD, G...	City Surveyor, St. Albans.
1897 Jan. 16	FORRESTER, R.	Surveyor to the Rural District Council, Basingstoke.
1890 Sept. 13	FOSTER, T.	Surveyor to the Urban District Council, Hoylake and West Kirby.
1900 June 16	FOTHERGILL, J. E.	Surveyor to the Urban District Council, Brentwood.
1873 May 2	FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	1 St. Peter's Square, Manchester; and 35 Old Queen Street, Westminster, S.W.
1897 Mar. 13	FOX-ALLIN, C. J.	Surveyor to the Urban District Council, Smethwick.
G1888 May 12 T1893 Oct. 21 R1898 Jan. 15	*FRANKS, T.W., Assoc. M. Inst. C.E.	Seveirg Chambers, Lewes.
G1898 June 30 T1902 Nov. 8	*FRASER, R. W.	Surveyor to the Urban District Council, Gainsborough.
1895 Oct. 19	FROST, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
1887 June 18 R1898 Jan. 15	FRY, W. H., A.M. Inst. C.E.	9 High Street, Gosport.
1877 Oct. 20	GAMBLE, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road, S.E.
1885 June 6	GAMMAGE J.	Borough Surveyor, Dudley.

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Date of Election and Transfer.		
1895 June 27	GAMMELL, H. H.	Surveyor to the Urban District Council, Perry Barr, near Birmingham.
1891 Dec. 12 R1899 June 10	GARRATT, C. T.	Estate Office, Newtown Linford, Leicestershire.
1894 Mar. 3	GARRETT, J. H.	County Surveyor, Worcester.
1886 Mar. 13 R1902 Feb. 22	GASKELL, P.	Albert Chambers, Carr Lane, Hull.
1886 Dec. 13	GEEN, H.	Borough Surveyor, Okehampton.
1902 Jan. 25	GENT, T. W. B.	Surveyor to the Rural District Council, Leigh.
1901 Oct. 19	GIBBS, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	GIBSON, S.	Surveyor to the Urban District Council, Biddulph.
1889 Dec. 14	GINN, A. F.	District Surveyor to the Kent County Council, Tonbridge. 70 Quarry Hill, Tonbridge.
1899 June 10	GLADWELL, A.	Highway Surveyor, Rural District Council, Eton. 1 Wrexham Road, Slough, Bucks.
1893 May 13	*GLOYNE, R.M., Assoc. M. Inst. C.E.	District Engineer, Spring Gardens, S.W.
1891 May 2	GODFREY, B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Rotherham.
1895 Jan. 19	GOLDER, T. C.	Borough Surveyor, Deal.
1873 Nov. 8	GOLDSWORTH, W.	Surveyor to the Urban District Council, Prescot, Lancashire.
1899 June 10	GONDIE, A. H.	Borough Engineer, Stirling.
1886 June 12	GOODYEAR, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
1897 June 19	GORDON, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
1901 Dec. 7	GORDON, J. C.	Borough Surveyor, Aldeburgh, Suffolk.
1897 Oct. 16	GRAHAM, G. A.	Surveyor to the Urban District Council, Witney.
G1897 June 19 T1901 Dec. 7	*GRANT, F. T...	Borough Surveyor, Gravesend.
G1887 Feb. 5 T1893 Apr. 22	*GREATOREX, A.D., A. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, West Bromwich.
1895 Mar. 5	GREEN, A. A.	Borough Surveyor, Brackley.
1899 June 10	GREEN, G., A.M. Inst. C.E...	Borough Engineer, Wolverhampton.
1901 Feb. 16	GREEN, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	GREEN, W.	Surveyor to the Urban District Council, Castleford.
1890 May 3 R1898 Apr. 23	GREENWELL, A., Assoc. M. Inst. C.E.	49 Essex Street, Strand, W.C.
1883 May 5 R1891 Dec. 12	GREENWOOD, A.	39 Calder Street, Todmorden.
1898 Mar. 19	GREGORY, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1892 Jan. 16	GREGSON, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	GREGSON, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.

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Date of Election and Transfer.		
1882 Sept. 30	GRIEVES, R.	Surveyor to the Urban District Council, Cowpen, Blyth, Northumberland.
1897 June 19	GRIEVES, W. H.	Surveyor to the Urban District Council, Buxton.
1892 Mar. 11	GRIFFITH, F., M. Inst. C.E.	Corporation Waterworks Engineer, Leicester.
1886 Sept. 11	GRIMLEY, S. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hendon.
1899 Dec. 16	GRIMSHAW, F. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Atherton.
1898 Dec. 17	GUILBERT, T. J.	States Surveyor, Guernsey.
1892 Apr. 28	GUNNIS, J. W.	County Surveyor, Longford, Ireland.
1890 Mar. 29	GUNYON, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Wood Green, N.
1891 Dec. 12	HACKETT, E. A., M.E., M. Inst. C.E.	County Surveyor, Clonmel, Tipperary, Ireland.
1885 June 6	HAIGH, J., A.M. Inst. C.E. ..	Borough Surveyor, Abergavenny.
1896 Apr. 25	HAINSWORTH, M.	Surveyor to the Urban District Council, Teddington.
1897 June 19	HAGUE, S.	Surveyor to the Urban District Council, Dukinfield.
1902 Sept. 6	HALE, A.	Municipal Engineer, Howrah, Bengal.
G1899 Dec. 16 T1901 Oct. 19	*HALL, C...	Surveyor to the Urban District Council, Droylsden, near Manchester.
1902 Nov. 8	HALL, E.	Borough Surveyor, Carnarvon.
1884 Apr. 19 R1903 Mar. 21	HALL, J., Assoc. M. Inst. C.E.	Executive Engineer, Municipal Offices, Bombay.
1886 May 1	HALL, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Great Crosby.
1900 June 16	HALLAM, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	HALLER, J. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Guiseley.
1894 July 7	HAMAR, A.	Borough Surveyor, Bishop's Castle, Shropshire.
1887 Mar. 12	HAMBY, G. H., A.M. Inst. C.E.	Borough Engineer, Lowestoft.
1897 Feb. 13	HAMP, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, New Swindon.
1897 Mar. 13	HANSON, J. H.	Surveyor to the Urban District Council, Cottingham, Yorks.
1890 Sept. 13	HANSON, W.	Surveyor to the Rural District Council, Wantage.
1896 Jan. 18	HARA, R.	Engineer to Tokio Fu, Japan.
1873 Feb. 15	HARDING, J. R., M. Inst. C.E.	Ashley Road, Epsom, Surrey.
G1896 Nov. 28 T1899 Jun. 10	*HARDING, W. D.	Borough Engineer, Bury St. Edmunds.
1899 Jun. 29	*HARGREAVES, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
1899 May 6	HARMAN, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.

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Date of Election and Transfer.		
1897 Mar. 13	HARPUR, A. O.	Surveyor to the Urban District Council, Caerphilly.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	Borough Engineer, Cardiff.
1896 Jan. 18	HARRIS, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.
1901 May 11	HARRISON, A., A.M. Inst. C.E.	Borough Engineer, Southwark. Town Hall, Walworth Road, S.E.
1899 Jun. 29	HARRISON, G. F. P.	Surveyor to the Rural District Council, East Stow. Stowmarket, Suffolk.
1896 Nov. 28	HARSTON, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Dartford.
1896 Oct. 24	HARTLEY, T. H.	Borough Surveyor, Colne.
1887 Jun. 18	HARTY, S., M. Inst. C.E. I. ..	City Engineer, Dublin.
1893 Oct. 21	HARVEY, T. F., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Merthyr Tydvil.
1892 Apr. 23	HAWLEY, G. W.	Highway Surveyor to the Rural District Council, Basford. York Chambers, King Street, Nottingham.
1902 July 10	HAYNES, H. T.	City Engineer, Perth, West Australia.
1895 Apr. 20	HAYNES, R. H.	Borough Engineer, Newport, Mon.
c1897 June 19 T1898 Jan. 15	*HAYWARD, T. W. A.	Borough Surveyor, Sudbury, Suffolk.
c1899 Jan. 12 T1903 June 25	*HAYWOOD, S. S.	Borough Engineer, Brighouse.
1899 June 10	HEATH, J.	Surveyor to the Urban District Council, Urmston.
1885 June 6	HEATON, G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Councils, Abram and Pemberton. King Street, Wigan.
1890 Feb. 1	HENDERSON, A. J., Assoc. M. Inst. C.E.	Surveyor to the District Highway Board, Kingston-on-Thames.
c1895 Jun. 27 T1901 Oct. 19	*HENDRY, J. S.	Surveyor to the Urban District Council, Cannock, Staffs.
1897 Feb. 13	HENRY, T.	Surveyor to the Rural District Council, East Retford.
1892 June 11	HERON, J., B.E., B.A.	County Surveyor, Co. Down. Courthouse, Downpatrick, Ireland.
1902 May 10	HESLOP, R.	Surveyor to the Urban District Council, Tanfield, Co Durham.
1899 May 6	HESLOP, T. H. B.	County Surveyor, Norfolk County Council, Norwich.
1875 Dec. 21	HEWSON, T., M. Inst. C.E. ..	City Engineer, Leeds.
1894 July 7	HIGGENS, T. W. E., Assoc. M. Inst. C.E.	Borough Surveyor, Town Hall, Chelsea, S.W.
1898 May 21	HIGGINS, J.	Chief Engineer, Grey Co., New Zealand.
1898 Dec. 17	HINCHCLIFFE, D.	Surveyor to the Urban District Council, Northallerton.

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Date of Election and Transfer.		
1893 July 13	HIND, H.	Surveyor to the Urban District Council, Erith.
1902 July 10	*HINES, C. E.	Surveyor to the Urban District Council, Windermere.
1898 Sept. 3	HIRST, R. P., A.M. Inst. C.E.	Borough Surveyor, Southport.
1895 June 27	HODGSON, W.	Surveyor to the Urban District Council, Keswick.
1873 Feb. 15 / R1885 Dec. 19	HODSON, G., M. Inst. C.E. ..	Loughborough. Abbey Buildings, Prince's Street, Westminster, S.W.
1896 Apr. 25 / R1901 May 11	*HOGBIN, L. W.	"Rowena," Preston Road, Leytonstone, N.E.
1890 Feb. 1	HOLDEN, J., A.M. Inst. C.E.	Highway Surveyor to the Rural District Council, Llandaff. Ely, Cardiff.
1897 Jan. 16	HOLE, W. P.	Borough Surveyor, Montgomery. Crowther's Hall, Welshpool.
1892 Mar. 11	HOLMES, G. W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Walthamstow, N.E.
1890 June 7 / R1903 Feb. 21	HOLT, G. F.	48 Cecil Road, Upton Manor, E.
1901 Dec. 7	*HOLT, W.	Surveyor to the Urban District Council, Sale, Cheshire.
1884 Oct. 9	HOOLEY, COSMO C., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Barton-upon-Irwell. Green Lane, Patricroft.
1884 Oct. 9	HOOLEY, E. P., A.M.Inst.C.E. (*Member of Council.*)	County Surveyor, Nottingham.
1898 Jan. 15	HOPKINSON, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 40 Bridge Street, Worksop.
1889 Sept. 21	HOPKINSON, W. H., A.M.Inst. C.E (*Member of Council.*)	Borough Engineer, Keighley; *Hon. Secretary*, Yorkshire District.
1891 Dec. 12	HORAN, J., M.E., M.Inst.C.E.	County Surveyor, 82 George Street, Limerick, Ireland.
1895 July 27	HORSFALL, W. H. D.	Surveyor to the Urban District Council, Southowram. 9 Harrison Road, Halifax.
1900 May 19	HORSFIELD, J. NIXON	Surveyor to the Urban District Council, Hampton Wick. Kingston-on-Thames.
1890 May 3 / R1903 Feb. 21	HORTON, G. S.	Nelson Terrace, Ranelagh Road, Felixstowe.
1902 Sept. 6	HOSKINS, M.	Surveyor to the Urban District Council, Oystermouth.
1894 Mar. 3	HOWARD, H.	Surveyor to the Urban District Council, Littlehampton.
1898 Sept. 3	HOWARD, S.	Surveyor to the Urban District Council, Bradford-on-Avon.
1889 Dec. 14 / R1898 Oct. 15	HOWARD-SMITH, W., Assoc. M. Inst. C.E.	"Naworth," Lanercost Road, Tulse Hill Park, S.W.
1880 May 27	HOWCROFT, J.	Surveyor to the Urban District Council, Redcar, Yorkshire.
1894 June 21	HOWELL, F. G.	County Surveyor, Surrey. Kingston-on-Thames.
1896 Feb. 22	HOWSE, W. T.	Surveyor to the Urban District Council, Bexley.

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Date of Election and Transfer.		
1897 June 17	HUGHES, H. T.	Highway Surveyor, Hayfield Road, Chapel-en-le-Frith.
1897 Jan. 16	HUMPHREYS, J.	Surveyor to the Urban District Council, Maesteg.
1899 June 1	HUMPHRIES, H. H.	Surveyor to the Urban District Council, Erdington.
1894 June 21	HUNT, G. J.	Borough Engineer, Dorchester.
1897 July 8	HUNTER, T.	Surveyor to the Urban District Council, Leigh.
G1891 Aug. 1 T1896 Apr. 25	*HURD, H.	Surveyor to the Urban District Council, Broadstairs.
G1901 Aug. 24 T1901 Dec. 7	*HUTTON, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
A1902 Feb. 22 T1903 Mar. 21	HUTTON, S.	Surveyor to the Urban District Council, Exmouth.
1898 Mar. 19	HUXLEY, J.	Surveyor to the Rural District Council, Hailsham.
1898 May 21	INGAMELLS, E. W...	Surveyor to the Urban District Council, Pokesdown.
G1895 Apr. 20 T1896 Oct. 24	*INGHAM, W., A.M. Inst.C.E.	Hydraulic Engineer, Port Elizabeth, South Africa.
1899 Feb. 25	INGRAM, S.	County Surveyor, Devon. Exeter.
1888 Nov. 17	IRVING, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.
1893 June 24 R1902 Nov. 8	ISAACS, L. H.	3 Verulam Buildings, Gray's Inn, W.C.
1900 July 19	JACK, G. H.	Surveyor to the Urban District Council, Aston Manor.
1893 Oct. 21	JAFFREY, W.	Town Surveyor, Matlock Bath.
1896 Oct. 24	JAMES, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
1900 Mar. 10	JAMES, J. P.	Borough Surveyor, Tenby.
G1887 Oct. 22 T1890 Mar. 29	*JAMESON, M. W.	Borough Engineer, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 13	JARVIS, R. W.	Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	JEEVES, E.	Surveyor to the Urban District Council, Melton Mowbray.
G1898 Jan. 15 T1903 Oct. 17	*JEFFES, B. H.	Surveyor to the Urban District Council, Cheshunt.
G1896 Jan. 18 T1896 Oct. 24	*JENKIN, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Finchley, N.
1899 June 10	JENKINS, D. M., A.M.Inst.C.E.	Borough Surveyor, Neath.
1880 Feb. 7	JENNINGS, G.	Borough Surveyor, Rotherham.
1895 May 25	JEPSON, J.	Surveyor to the Urban District Council, Leveushulme.
1892 July 21	JEVONS, J. H., A. M. Inst. C.E.	Borough Surveyor, Hertford.
1895 June 27	JOHNSTON, J., Assoc. M. Inst. C.E.	Waterworks Engineer, Brighton.

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Date of Election and Transfer.		
1883 Aug. 4 R1902 Nov. 8	JONES, E. C., Lt.-Col. A. S., Assoc. M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
1873 Feb. 15	JONES, CHAS., M. Inst. C.E. (*Past President and General Hon. Secretary.*)	Borough Surveyor, Ealing, Middlesex.
1894 July 7	JONES, CHRISTOPHER	Borough Surveyor, Hythe, Kent.
1874 Jan. 29	JONES, I. M., M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
1894 June 21	JONES, J.	Surveyor to the Rural District Council, Hengoed, *viâ* Cardiff.
1894 June 21	JONES, J. O.	Surveyor to the Rural District Council, Biggleswade.
1903 June 6	JONES, R. R.	Surveyor to the Urban District Council, Horsforth.
1900 Mar. 10	JONES, T. C.	Surveyor to the Urban District Council, Redruth.
1892 May 28	JONES, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council. Colwyn Bay.
1897 Feb. 13	JONES, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	JONES, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1891 June 25	JUKES, W. H.	Surveyor to the Urban District Council, Tipton.
1895 July 27 R1899 Dec. 16	KAY, W. R., A.M. Inst. C.E.	Athol Street, Douglas, Isle of Man.
1889 Feb. 9	KEMP, J., Assoc. M. Inst. C.E.	Engineer to the Municipality of Brisbane, Queensland.
1892 Apr. 23	KENNEDY, J. D.	Borough Surveyor, Retford.
1895 May 25	KEYWOOD, H. G.	Surveyor to the Rural District Council, Maldon.
1892 July 11	KIDD, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
1899 Oct. 21	KILLICK, J. S.	Surveyor to the Rural District Council, Maidstone.
1899 June 29	KILLICK, P. G.	Borough Surveyor, Finsbury, E.C.
1902 May 10 R1903 July 25	KINNISON, A. M.	Abbey Cottage, Leek, Staffs.
1888 Sept. 15	KIRK, T., Assoc. M. Inst. C.E.	Town Engineer, Ipswich, Queensland.
1892 Mar. 11	KIRKBY, S. A., M.A.	County Surveyor, Cork (South division), East Riding. Miramur, Queenstown.
1895 Oct. 19	KNAPP, R. W.	Borough Surveyor, Andover.
1903 June 25	*KNEWSTUBB, F. W.	Surveyor to the Urban District Council, Haverhill.
1903 June 25	*KNEWSTUBB, J. J.	Surveyor to the Urban District Council, Penrith.
1894 Mar. 3 R1903 Jan. 17	KNIGHT, J. M., A.M. Inst. C.E.	35 Bancroft Road, Mile End, E.
1884 Oct. 9	LACEY, F. W., M. Inst. C.E. ..	Borough Engineer, Bournemouth.
G1893 Jan. 14 T1895 Mar. 16	*LACEY, G. W.	Borough Surveyor, Oswestry.

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Date of Election and Transfer.		
1882 May 25 R1902 Jan. 25	LAFFAN, G. B., M. Inst. C.E.	Hardy's Chambers, Pietermaritzburg.
1900 Dec. 15	LAILEY, H. G. N.	Surveyor to the Urban District Council, Trowbridge.
1900 July 19	LAITHWAITE, V.	Surveyor to the Urban District Council, Turton.
1891 June 6	LANDLESS, J. T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Brierfield, Lancs. Station Buildings, Nelson.
1894 June 21 R1902 Nov. 8	LATHAM, A., M. Inst. C.E. ..	Municipal Buildings, Margate.
1895 May 25	LAURENS, F., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cookham. 23 St. Luke's Close, Maidenhead.
1882 Apr. 15	LAWS, W. G., M. Inst. C.E. (*Past President.*)	95 Osborne Road, Newcastle-on-Tyne.
1897 Jan. 16	LAWSON, A.W., A.M.Inst.C.E.	Borough Surveyor, Rawtenstall.
1884 July 10	LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1900 Mar. 10	LAWTON, C. H.	Surveyor to the Urban District Council, Warminster. Christchurch Cottage, Warminster, Wilts.
G1899 Oct. 21 T1901 May 11	*LEA, M.	City Surveyor, Truro.
1896 Oct. 24	LEEBODY, J. W.	County Surveyor, Co.Tyrone(S.)
1898 Mar. 19	LEETE, H. J. G.	County Surveyor, Huntingdon.
1880 Apr. 10	LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1900 May 19	LEGG, E. I.	BoroughSurveyor,Christchurch, Hants.
1894 May 19	LEIGH, W.	Borough Surveyor, Chorley.
1873 Feb. 15	LEMON, J., M. Inst. C.E. (*Past President.*)	Consulting Engineer, Southampton; and 11 Victoria Street, Westminster, S.W.
1899 Oct. 21	LINES, E.	Engineer to the Rural District Council, Chesterfield.
G1896 July 25 T1899 Dec. 16 R1903 Feb. 21	*LIVERSEDGE, J. W.	Wigan Road, Ashton-in-Makerfield.
1891 Mar. 21 R1901 Aug. 24	LIVINGSTONE, G., Assoc. M. Inst. C.E.	17 Victoria Street, Westminster, S.W.
G1895 May 25 T1900 Oct. 15	*LOBLEY, F., A.M. Inst. C.E.	Town Surveyor, Hale, Cheshire.
1873 May 2	LOBLEY, J., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	Borough Engineer, Hanley, Staffordshire.
1896 June 25	LOCKE, W. R.	Borough Surveyor, Town Hall, Hemel Hempstead.
1889 Sept. 21	LOMAX, C. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Gorton. 37 Cross Street, Manchester.
1896 Oct. 24	LONGFIELD, R. W. F., Assoc. M. Inst. C.E.	County Surveyor, Co. Cork (W.). Bandon.
1902 Nov. 8	LORD, E. I.	Borough Engineer, Greymouth, New Zealand.
1901 May 11	LOVEDAY, W. F.	Borough Surveyor, Stoke Newington, N.
1892 Jan. 16	LOVEGROVE, E. J., M. Inst. C.E. (*Member of Council.*)	Engineer to the Urban District Council, Hornsey, N.

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Date of Election and Transfer.		
1887 June 18	LOWE, C. H., M. Inst. C.E. (*Past-President.*) (*Member of Council.*)	30 Somerset Street, Portman Square, W.
1897 July 8	LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	LUND, C.	Surveyor to the Urban District Council, Cleckheaton.
1896 Oct. 24	LYNAM, F. J., Assoc. M. Inst. C.E.	County Surveyor, Co. Tyrone (N.)
G1888 July 12 T1897 Oct. 16	*LYNAM, G. T., Assoc.M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1891 Aug. 1	LYNAM, P. J.	County Surveyor, Louth. Dundalk, Ireland.
1873 May 2 R1900 Mar. 10	MCBEATH, A. G., Assoc. M. Inst. C.E.	Montagu Road, Sale, Cheshire.
1883 May 30	MACBRAIR, R. A., Assoc. M. Inst. C.E.	City Engineer, Lincoln.
1900 Feb. 10	MCDERMID, C.	Surveyor to the Urban District Council, Eston.
1897 Feb. 13	MCDONALD, A. B., M. Inst. C.E.	City Engineer, Glasgow.
1897 Jan. 16	MACKENZIE, D.	County Surveyor, Dunfermline.
1895 Oct. 19	MCKENZIE, J. MCD.	Surveyor to the Rural District Council, Bucklow. 7 Market Street, Altrincham.
1879 Oct. 23 R1889 Oct. 19	MCKIE, H. U., M. Inst. C.E.	The White House, Spondon, Derby.
1898 June 30	MCKILLOP, R.	Burgh Surveyor, Perth, N.B.
1898 Feb. 19	MADIN, W. B.	Surveyor to the Urban District Council, Rushden.
1897 Mar. 13	MAGER, F. W.	Surveyor to the Rural District Council, Walsall.
1886 Dec. 18	MAIR, H., Assoc. M. Inst. C.E.	Borough Engineer, Hammersmith, W.
1900 Feb. 10	MALLINSON, J.	Surveyor to the Urban District Council, Skipton.
G1891 Jan. 21 T1897 June 19	*MANLEY, J.	Late Borough Surveyor, Wokingham.
1892 July 21	MANNING, G. W.	Surveyor to the Rural District Council, Staines.
G1898 Jan. 15 T1901 Aug. 24	*MARKS, C. W...	Borough Surveyor, Wokingham.
1888 July 12	MARKS, H. C., A. M. Inst.C.E.	City Surveyor, Carlisle.
1899 May 6	MARKS, W. L.	Surveyor to the Urban District Council, Rhymney.
1901 May 11	MARSH, F. G...	"Dulton," Derby Road, Surbiton.
1897 Mar. 13	MARSHALL, J...	Surveyor to the Rural District Council, West Malling.
1891 Jan. 21 R1902 Nov. 8	MARSTON, C. F., Assoc. M. Inst. C.E.	44 High Street, Sutton Coldfield.
1894 Mar. 3	MARTEN, H. J., Assoc. M. Inst. C.E.	Borough Surveyor, Eastern District, Wandsworth. 215 High Road, Balham, S.W.
1890 Mar. 29 R1898 Mar. 19	MASON, C., Assoc.M.Inst.C.E.	Beeston, near Nottingham.
1899 May 6	MASON, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.

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Date of Election and Transfer.		
1890 Mar. 29	MASSIE, F., A.M. Inst. C.E.	Surveyor to the Rural District Council, Wakefield.
1883 Feb. 17	MATHEWS, G. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Dorking.
1898 Dec. 17	*MATTHEWS, E. R.	Surveyor to the Urban District Council, Bridlington.
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*Past President.*) (*Member of Council*).	Borough Engineer, Leicester.
1892 Mar. 11	MAWSON, R. C.	Borough Surveyor, Evesham.
G1896 July 25 T1902 Sept. 6	*MAXWELL, W. H., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
1875 May 1	MAY, F. J. C., M. Inst. C.E. (*Past President*) (*Member of Council*)	Borough Engineer and Surveyor, Brighton.
1894 Oct. 20	MAYBURY, H. P.	Surveyor to the Urban District Council, Great Malvern.
1901 Aug. 24	MAYLAN, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	MAYNE, C., M. Inst. C.E. ..	Engineer and Surveyor to the Municipal Council, Shanghai. *Hon. Corresponding Sec.* for Eastern Asia.
1883 Feb. 17	MEADE, T. DE COURCY, M. Inst. C.E. (*Past President.*)	City Surveyor, Manchester.
G1888 Jan. 14 T1894 Oct. 20 R1900 Apr. 21	*MELLOR, T. E. W., Assoc. M. Inst. C.E.	Withington, Boyne Park, Tunbridge Wells.
1888 July 12	*METCALF, J. W., Assoc. M. Inst. C.E.	Town Surveyor, Newmarket.
1903 June 25	*METCALFE, A. J.	Surveyor to the Rural District Council, Bourne.
1890 June 7	MIDDLETON, R. H., Assoc. M. Inst. C.E.	Borough Surveyor, Walsall.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk, Ipswich.
1902 July 10	MILLER, H.	Surveyor to the Urban District Council, Heysham.
1893 June 24	MILLS, J. H.	Oak Street, Shaw, near Oldham.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
1874 May 23	MITCHELL, J.	Borough Surveyor, Hyde, Manchester.
1887 July 14	MOLINEUX, W. F. Y.	Engineer and Surveyor to the Rural District Council, Ulverston.
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, Stafford.
1900 Dec. 15	MONTEATH, G.	County Surveyor, Newtown, St. Boswell's, N.B.
1891 Oct. 17	MOORE, J. H.	County Surveyor, Co. Meath. 63 Eccles Street, Dublin.
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.

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Date of Election and Transfer.		
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
1898 June 30	MORRIS, F. J...	Borough Surveyor, Grantham.
1891 Aug. 1	MORTIMER, J.	Surveyor to the Urban District Council, Tettenhall, near Wolverhampton.
1903 Feb. 21	MOULDING, T., A.M.Inst.C.E.	City Surveyor, Exeter.
A1902 Jan. 25 T1902 June 7	*MOUNT, J. C., A.M. Inst. C.E.	Borough Surveyor, Lancaster.
1885 Feb. 7	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Withington, near Manchester.
1901 Feb. 16	*MOYNIHAN, M. A.	Surveyor to the Urban District Council, Westport, Co. Mayo.
1898 Sept. 3	MULVANY, C. J., M. Inst. C.E.	County Surveyor, Roscommon.
1890 Mar. 29	MURCH, P.	Borough Engineer, Portsmouth.
1896 Nov. 28	MURPHY, P. E., Assoc. M.Inst. C.E.	Engineer to the Tottenham and Wood Green Joint Drainage Committee. 712 High Road, Tottenham, N.
1895 Feb. 16	MURZBAN, KHAN BAHADUR M. C., C.I.E., M. Inst. C.E.	Executive Engineer, Bombay.
1896 Oct. 24	NANKIVELL, H. H.	Surveyor to the Urban District Council, Braintree.
1893 July 31	*NETTLETON, H., Assoc. M. Inst C.E.	Surveyor to the Urban District Council, Weston-super-Mare.
1900 Feb. 10	NEWEY, W. F.	Surveyor to the Urban District Council, Nantwich.
1877 May 1	NEWMAN, F.	County Surveyor, Isle of Wight. Ryde.
1897 July 8	NEWMAN, S. J.	Surveyor to the Urban District Council, Branksome.
1897 Feb. 13 R1903 Jan. 17	NEWTON, C. E.	17 Cooper Street, Manchester.
G1895 Jan. 19 TA1901 Oct. 19 T1902 Mar. 22	*NEWTON, E. B., A.M. Inst. C.E.	Borough Surveyor, Paddington, W.
1891 Oct. 17	NEWTON, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
1888 May 12	NEWTON, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
G1892 Sept. 24 T1899 Feb. 25	*NICHOLS, A. E., A.M. Inst.C.E.	Borough Engineer, Folkestone.
1887 July 14 R1899 Feb. 25	NORRINGTON, J. P., Assoc. M. Inst. C.E.	17 Victoria Street, Westminster, S.W.
G1897 Mar. 13 T1898 Sept. 3	*NORRIS, J. H.	Borough Surveyor, Godalming.
1886 Dec. 18 R1901 May 11	NORRISH, G. R.	Hawley House, Tudor Road, Upper Norwood.
1900 Dec. 15	NUTTALL, H.	Surveyor to the Urban District Council, Kearsley.

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Date of Election and Transfer.		
1899 Feb. 25	NUTTALL, W.	Surveyor to the Urban District Council, Prestwich.
c1898 June 30 T1899 Oct. 21	*OAKDEN, R. A.M. Inst. C.E. ..	Surveyor to the Rural District Council, Newark.
1901 Aug. 24	O'HARA, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1891 Aug. 1	ORCHARD, W. P., B.E.	County Surveyor, Ballina, North Mayo, Ireland.
1892 Jan. 16	OXTOBY, W., A.M. Inst. C.E.	Borough Engineer, Camberwell, S.E.
1896 July 25	*PALLISER, W. A.	Town Engineer, East London, Cape of Good Hope.
1896 Apr. 25	PALMER, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
1900 Mar. 10	PALMER, P. H.	Borough Surveyor, Hastings.
1894 Apr. 6	PARDOE, J. C., Assoc. M. Inst. C.E	Surveyor to the Urban District Council, Barry, near Cardiff.
1876 May 1	PARKER, J., A.M. Inst. C.E.	City Surveyor, Hereford.
1887 July 14 R1895 June 27	PARKER, J., A.M. Inst. C.E.	107 Bedford Court Mansions, Bedford Square, W.C.
1896 Nov. 28 R1903 Feb. 21	PARKER, J. E., A.M.Inst.C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	PARKER, S. W.	Surveyor to the Urban District Council, Thornhill.
1893 July 13	PARR, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
c1893 Jan. 14 T1894 Oct. 20	*PARR, N.	Surveyor to the Urban District Council, Brentford.
c1898 June 30 T1899 Oct. 21	*PARR, F. H.	Surveyor to the Urban District Council, Wealdstone.
1894 June 21	PATON, J. (*Member of Council.*)	Borough Engineer, Plymouth.
1895 Jan. 19	PATTISON, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
1897 Jan. 16	PEACOCK, T. J.	Surveyor to the Rural District Council, Spalding.
1898 Dec. 17	PEARCE, F. W.	Surveyor to the Urban District Council, Twickenham.
1894 Mar. 3	PEARSON, W. T.	Surveyor to the Urban District Council, Rothwell, Northants.
1897 Feb. 13	PEASE, C. R.	Borough Surveyor, Todmorden.
1899 Oct. 21	PEET, H. F.	City Engineer, Bloemfontein, South Africa.
1891 Dec. 12	PEIRCE, R., Assoc.M.Inst.C.E.	Municipal Engineer, Singapore.
1896 Nov. 28	PERRINS, B.	Surveyor to the Urban District Council, Redditch.
1891 Sept. 12	PERRY, J., M.E., M.Inst.C.E.	County Surveyor, Co. Galway (West Riding), Galway.
1898 May 21	PETCH, W. J.	Surveyor to the Urban District Council, Leigh-on-Sea, Essex.
1889 May 18	PHILLIPS, R., A.M. Inst. C.E.	County Surveyor, Gloucester.
1901 Oct. 19	PICKARD, J. E.	Borough Surveyor, Pontefract, Yorks.
1901 Aug. 24	PICK, S. P.	County Surveyor, Leicester. 6 Millstone Lane, Leicester.

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Date of Election and Transfer.			
1898 Apr. 23		PICKER, E.	Surveyor to the Rural District Council, Beverley.
G1887 June 18 T1890 Sept. 13		*PICKERING, J. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Cheltenham. *Hon. Secretary*, Western District.
1881 Dec. 10 R1884 May 29		PICKERING, R.	11 Lowther Street, Whitehaven.
G1894 Jan. 13 T1895 Oct. 19		*PICKERING, S. A., A.M. Inst. C.E.	Borough Surveyor, 86 Waterloo Street, Oldham.
G1894 Jan. 13 T1895 Oct. 19		*PICKLES, G. H., A.M.Inst.C.E.	Borough Surveyor, Burnley.
1881 Dec. 10		PLATT, S. S., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale.
1893 Oct. 21		PLOWRIGHT, A. H...	Borough Engineer, Wisbech, Cambs.
1884 Mar. 15 R1885 Oct. 3		POLLARD, J., M. Inst. C.E. ..	31 Old Queen Street, Westminster, S.W.
1897 July 8		POOLE, H. C.	Surveyor to the Urban District Council, Wath-upon-Dearn.
1881 July 7		PORTER, R.	Borough Surveyor, Wakefield.
1899 Jan. 21 R1901 May 11		POWELL, J.	4–6 Victoria Chambers, Terminus Street, East London, Cape Colony.
1902 Feb. 22		POWELL, J. G.	Surveyor to the Rural District Council, Godstone, Surrey.
1891 Sept. 12		PRATT, R.	Borough Surveyor, Henley-on-Thames.
1899 Oct. 21		*PRESCOTT, A. E.	Borough Surveyor, Douglas, Isle of Man.
1898 Mar. 19		PRESCOTT, W. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Tottenham, N.
1892 Jan. 16		PRESS, W. J.	Surveyor to the Urban District Council, Burnham, Somerset.
G1894 June 21 T1899 June 29		*PRICE, A. J.	Surveyor to the Urban District Council, Lytham.
1879 May 1		PRICE, J., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Birmingham.
1873 May 2		PROCTOR, J., M. Inst. C.E. ..	Mere Lawn, Bolton, Lancashire.
1897 Feb. 13		PROFFITT, J. T.	Surveyor to the Urban District Council, Worsley, Walkden, Bolton.
1892 May 28		PROUSE, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1900 Oct. 15		PULLAR, W. M.	Shire Engineer, Coburg, Victoria.
1873 May 2		PURNELL, E. J.	Water Engineer, Coventry, Warwickshire.
1899 May 6		PURSER, W. B., A.M. Inst. C.E.	County Surveyor, Kesteven County Council, Grantham.
G1893 July 31 T1898 June 13		*PUTMAN, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
1897 May 15		PYM-JONES, I.	City Surveyor, Chichester.
1886 Dec. 18 R1901 Oct. 19		RADFORD, J. C., A. M. Inst. C.E.	163 Upper Richmond Road, Putney, S.W.
1889 July 4		RAPLEY, W.	Surveyor to the Rural District Council, Dorking.

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Date of Election and Transfer.		
1898 Apr. 23	RAYNER, F. J.	Surveyor to the Urban District Council, Newhaven.
1878 May 1	READ, R., A.M. Inst. C.E. ..	City Surveyor, Gloucester.
1899 May 6	REES, E.	Surveyor to the Urban District Council, Pontypridd.
1898 Dec. 17	REID, R. M.	Highway Surveyor to the Stirlingshire County Council, 46 Barnton Street, Stirling.
1902 Jan. 25	REID, S., Assoc. M. Inst. C.E.	Municipal Engineer, Penang, S.S.
1897 Feb. 13	RENWICK, R.	Surveyor to the Urban District Council, Horsham.
1892 Mar. 11	REYNOLDS, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
1888 July 12 R1902 Feb. 22	RICHARDS, R. W., Assoc. M. Inst. C.E.	Mutual Life of N.Y. Building, Martin Place, Sydney.
1888 May 12	RICHARDSON, H., Assoc. M. Inst. C.E. (*Member of Council*)	Surveyor to the Urban District Council, Handsworth. *Hon. Secretary*, Midland District.
1884 Oct. 9	RICHARDSON, J.	Surveyor to the Urban District Council, Stamford.
1901 May 11	*RIDLER, W.	Borough Surveyor, Tewkesbury.
1892 Mar. 11	RIDOUT, A. R.	Surveyor to the Urban District Council, Stone.
1896 Nov. 28	ROBERTS, D.	Borough Surveyor, Lewes.
G1891 Dec. 12 T1897 Mar. 13	*ROBERTS, F., A. M. Inst. C.E.	Borough Engineer, Worthing.
1893 Jan. 14	ROBINSON, A. R.	Surveyor to the Urban District Council, Clacton-on-Sea.
1891 Oct. 17	ROBINSON, W. P., A.M. Inst. C.E.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
1886 May 1	ROBINSON, W. J.	City Surveyor, Londonderry.
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
1896 Mar. 21	RODWELL, A.	Surveyor to the Rural District Council, Skipton.
1896 Jan. 18	ROGERS, W. E.	Surveyor to the Urban District Council, Rugely.
1903 July 25	ROSS, D. J., M. Inst. C.E. ..	City Engineer, Guildhall, London.
1895 Jan. 19	ROSS, John C., A.M. Inst. C.E.	Town Engineer, Warrnambool, Victoria, Australia.
1892 July 11	ROTHERA, F. B.	Surveyor to the Urban District Council, Featherstone.
1880 Oct. 2	ROUNTHWAITE, R. S., Assoc. M. Inst. C.E.	City Engineer, Wellington, New Zealand.
1893 July 13 R1903 Mar. 21	ROWLAND, J.	15 The Village, Old Charlton, Kent.
1888 May 12	RUCK, F. W.	County Surveyor, Kent. Maidstone.
1895 Feb. 16	RUSHBROOKE, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*RUSHTON, E.	Surveyor to the Urban District Council, Cleethorpes.
1880 June 23 R1903 Jan. 17	SADLER, G. W.	467 High Street, Cheltenham.
1890 Mar. 29	*SAISE, A. J., Assoc. M. Inst. C.E.	Ventnor House, Forest Road, Fishponds, Bristol.

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Date of Election and Transfer.		
1899 Feb. 25	SALKIELD, T.	Surveyor to the Urban District Council, Leatherhead.
G1887 June 18 T1898 May 21	*SAUNDERS, J.	Imperial Chambers, Newark.
1894 Mar. 3	SAVILLE, J.	Town Surveyor, Heckmondwike.
1899 May 6	SCHOFIELD, W. H., A.M. Inst. C.E	County Surveyor, Lancashire. County Hall, Preston.
1894 June 21	SCORGIE, N., A.M. Inst. C.E.	Borough Surveyor, Hackney, N.E.
1892 Sept. 24	SCOTT, A. F.	Surveyor to the Urban District Council, Cromer.
1888 Nov. 17	SCOTT, H. H., A.M.Inst.C.E.	Engineer to the Commissioners, Hove.
1901 Aug. 24	SCOTT, J. H.	Surveyor to the Urban District Council, Winton, Bournemouth.
1880 May 27	SCOTT, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 13	SCOTT, T.	Surveyor to the Rural District Council, Tadcaster.
1897 July 8	SENIOR, C. E...	Surveyor to the Urban District Council, Neston, Cheshire.
1896 Oct. 24	SENIOR, J. S.	Surveyor to the Urban District Council, Swanage.
G1894 July 7 T1898 Mar. 19	*SETTLE, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Heywood, Manchester.
1873 May 2 R1903 May 16	SHARMAN, E.	Croyland Abbey, Wellingborough, Northamptonshire.
1896 Nov. 28	SHARPE, J. E.	Surveyor to the Urban District Council, Otley.
1891 June 6	SHAW, H., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Ilford.
1890 June 7 R1901 Aug. 24	SHAW, J. H.	Shenstone Cottage, Brownhills, Staffs.
1892 May 28	SHEARD, W. C., Assoc.M. Inst. C.E.	"Stonelea," Newtown, New Mills, near Stockport.
1891 Oct. 17	SHEPHERD, G. J.	Surveyor to the Rural District Council, Kidderminster.
1884 June 10	SHEPPARD, G.	Borough Surveyor, Newark.
1892 July 11	SHILLINGTON, H., M.E. ..	Town Surveyor, Lurgan, Ireland.
1895 Oct. 19	SHIPTON, T. H.	Surveyor to the Urban District Council, Oldbury.
1902 June 7	SIDDALLS, J.	Borough Surveyor, Tiverton.
1887 Oct. 22	SIDDONS, J. M.	Surveyor to the River Nene Commissioners, Oundle.
1896 Jan. 18	SIDWELL, H. T.	Surveyor to the Rural District Council, Rochford, Essex.
1887 July 14 R1898 Oct. 15	*SILCOCK, E. J., M. Inst. C.E.	10 Park Row, Leeds.
1897 Mar. 13	SILCOCK, H.	Surveyor to the Rural District Council, Blackwell, Mansfield.
1903 June 25	SIMCOX, G.	Borough Surveyor, Dunstable Beds.
1903 Oct. 17	SIMMONDS, T. B	Surveyor to the Urban District Council, New Malden.
1901 Feb. 16	SIMPSON, H. F.	County Surveyor, Northern Division, Isle of Ely. Wisbech.

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Date of Election and Transfer.		
1891 Aug. 1 R1895 June 27	SIMPSON, W. H., A. M. Inst. C.E.	Horsefair Street, Leicester.
1890 Sept. 13	SINCLAIR, J. S., A.M. Inst. C.E.	Borough Surveyor, Widnes.
1895 Oct. 19	SKELTON, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
1899 Oct. 21	SLOCOMBE, D. W.	Surveyor to the Urban District Council, Brynmawr.
1898 Oct. 15	SMAIL, J. M., M. Inst. C.E. ..	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S.W.
1898 June 30	SMALES, J. E.	Surveyor to the Urban District Council, Ware.
1895 June 27	SMILLIE, J. F.	Borough Surveyor, Tynemouth.
1899 Dec. 16	SMITH, ARTHUR	Borough Surveyor, Dartmouth.
1892 Mar. 11	SMITH, C. CHAMBERS	Surveyor to the Urban District Council, Sutton, Surrey.
1902 Sept. 6	SMITH, F. H.	Surveyor to the Urban District Council, Portishead.
1899 Mar. 25	SMITH, H. W., A.M. Inst. C.E.	Borough Engineer, Scarborough.
1892 Mar. 11	SMITH, J., B.E., M. Inst. C.E.	County Surveyor, Co. Galway (E. Riding), Ballinasloe.
1897 May 15	SMITH, JAMES	Borough Surveyor, Buckingham.
1895 May 25	SMITH, J. B.	Surveyor to the Urban District Council, Tyldesley.
1899 Oct. 21	SMITH, J. D.	County Road Surveyor, Wigtownshire. 1 Newton Terrace, Stranraer.
1901 Dec. 7	SMITH, J. GOULD, A.M. Inst. C.E.	Borough Surveyor, Beverley.
1879 May 1	SMITH, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire. *Hon. Secretary*, North Wales District.
G1898 Dec. 17 TA1901 Oct. 19 T1903 Oct. 17	*SMITH, J. W.	Borough Surveyor, Barrow-in-Furness.
1891 Dec. 12	SMITH, T. R.. A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	SMITH, V.	Surveyor to the Urban District Council, Teignmouth.
G1888 Jan. 14 T1897 Mar. 13	*SMITH-SAVILLE, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
1887 Sept. 13	SMYTHE, F.	Surveyor, Finchley, N.
1898 Jan. 15	SNELL, J. F. C., A.M. Inst. C.E.	Borough Electrical Engineer, Sunderland.
1903 Oct 17	SOWDEN, M.	Surveyor to the Urban District Council, Whitchurch, Salop.
1898 Dec. 17	SPENCER, J.	Surveyor to the Urban District Council, Oakworth. York Chambers, Cooke Street, Keighley.
1873 May 2 R1881 Dec. 10	SPENCER, J. P., A.M. Inst. C.E.	13 Grainger Street West, Newcastle-on-Tyne.
1902 May 10	SPENCER, L. G.	Borough Surveyor, Melrose, Wellington, New Zealand. 90 Constable Street, Newtown, Wellington, New Zealand.
1885 June 25 R1888 Sept. 15	SPINKS, W., M. Inst. C.E. ..	39 Prudential Assurance Buildings, Park Row, Leeds.
1880 Feb. 7 R1899 June 10	STAINTHORPE, T. W., A.M. Inst. C.E.	P.W.D., Cape Town, South Africa.

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Date of Election and Transfer.		
1889 Dec. 14	STALLARD, S., A.M. Inst. C.E.	Highway Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1898 June 30	STANSFIELD-BRUN, J.	Borough Surveyor, Lymington.
1892 July 21 R1900 Apr. 21	STEAD, S.	33 James Street, Harrogate.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1886 July 8	STEVENS, G.	Surveyor to the Urban District Council, Abercarn, Mon.
1890 Mar. 29	STEVENS, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
1892 Mar. 11	STEVENSON, A.	District Surveyor, Ayrshire County Council.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1901 Feb. 16	STEWART, J.	Surveyor to the Urban District Council, Leighton Buzzard.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., A.M.Inst.C.E.	Borough Engineer and Surveyor, Dover.
1895 Feb. 16	STIRRAT, J.	Municipal Engineer, Rangoon.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1887 Sept. 17	STOKOE, J.	Surveyor to the Urban District Council, Altrincham.
1898 Mar. 19	STOW, J. F.	Surveyor to the Rural District Council, Uxbridge.
1903 Mar. 11	STREATHER, W. T.	Surveyor to the Urban District Council, Waltham Cross.
G1893 June 24 T1893 July 13	*STRINGFELLOW, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ashbourne, Derbyshire.
1880 May 27	STUBBS, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
G1892 July 11 T1892 Sept. 24	*SUMNER, F., A.M. Inst. C.E.	Borough Engineer, Woolwich.
1895 Mar. 16	*SURTEES, R. T.	Water Engineer to the Urban District Council, Newton-in-Makerfield. Newton-le-Willows, Lancs.
G1899 June 29 T1901 June 27	*SWALES, T. R.	Borough Surveyor, Maldon.
1880 June 23 R1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	30 St. Anns Street, Manchester.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton-on-Tees.
1887 Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1895 Mar. 16	TARBIT, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
1891 Mar. 21 R1903 Mar. 21	TAYLOR, H. W., Assoc. M. Inst. C.E.	St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.
1890 Sept. 13	TAYLOR, T. G.	Borough Surveyor, Ramsgate.
G1891 Sept. 12 T1897 Oct. 16	*TAYLOR, W. J., Assoc. M. Inst. C.E.	County Surveyor, Hants. Winchester.
1892 Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.
1901 Feb. 16	*THOMAS, R. A.	Surveyor to the Urban District Council, Menai Bridge.

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Date of Election and Transfer.		
1892 Mar. 11	*Thomas, R. J., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Bucks. Aylesbury. *Hon. Secretary*, Home District.
1890 May 3	Thomas, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1902 May 10	Thomas, W. B.	Surveyor to the Urban District Council, Southwick-on-Wear.
1887 Sept. 17	Thomas, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath; *Hon. Secretary*. South Wales District.
1891 Jan. 21	Thorpe, J.	Surveyor to the Rural District Council, Macclesfield.
1898 Jan. 15	Thropp, J.	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
1898 Apr. 23	Thwaites, W., M. Inst. C.E.	Chief Engineer to the Metropolitan Board of Works, Melbourne, Australia.
G1891 June 6 T1893 Oct. 21	*Tomes, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
1895 Mar. 16	Tooley, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
1890 May 3	Towlson, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
1894 Oct. 20	Travers, W. H.	Surveyor to the Urban District Council, Wallasey.
1897 Jan. 16	Tressider, W. H.	Borough Surveyor, Falmouth.
1897 Feb. 13	Trinder, C. D. M.	Surveyor to the Rural District Council, Claypole, Newark.
1901 Feb. 16	Trowsdale, T. J.	Surveyor to the Urban District Council, Annfield Plain, Co. Durham.
1893 Oct. 21	Turley, A. C., A.M.Inst.C.E.	City Engineer, Canterbury.
1897 Mar. 13	Turner, H. H.	Surveyor to the Rural District Council, Limehurst, Lancs. 2 Grace Street, Old Square, Ashton-under-Lyne.
1899 June 10	*Turner, S.	Surveyor to the Rural District Council, Ashby-de-la-Zouche.
1898 June 30	Turriff, A. A.	Burgh Surveyor, Elgin, N.B.
1889 Sept. 21	Vallance, R. F.	Borough Surveyor, Mansfield.
1887 Oct. 22	Valon, W. A. McIntosh, Assoc. M. Inst. C.E.	Ramsgate Corporation Gasworks Engineer. 140 and 141 Temple Chambers, Temple Avenue, E.C.
1901 Mar. 23	Vawser, C.	Surveyor to the Urban District Council, Cheriton, near Folkestone.
G1894 Jan. 13 T1901 Dec. 7 R1903 Feb. 21	*Veit, L. J.	1 Pimlico Road, S.W.
1889 Sept. 21 R1903 Jan. 17	Ventris, A., Assoc. M. Inst. C.E.	"Campton," Arkwright Road, Hampstead, N.W.
1897 June 19	Vincent, S. J. L., A. M. Inst. C.E.	Borough Surveyor, Newbury.
1894 June 21	Waddington, J. A. P., Assoc. M. Inst. C.E.	Borough Engineer, Marylebone, W.

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Date of Election and Transfer.		
1902 June 7	WAKEFORD, J. P., A. M. Inst. C.E.	Surveyor to the Urban District Council, Bilston.
1888 July 12	WAKELAM, H. T., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Middlesex. Guildhall, Westminster, S.W.
1898 Sept. 3	WALKER, A. H., A. M. Inst. C.E.	Borough Surveyor, Loughborough.
1873 May 2	WALKER, T., M. Inst. C.E. ..	Late Borough Surveyor, Croydon, Surrey.
1889 July 4	WALLACE, G.	Borough Engineer, Holborn, E.C.
1887 June 18	WALSHAW, J. W.	Borough Surveyor, Peterborough.
1899 Jan. 21	WARD, J., A. M. Inst. C.E. ..	Borough Engineer, Derby.
1886 July 8	WARDLE, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
1890 May 3	WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.
1892 Mar. 11	WATKEYS, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
1887 June 18	WATSON, J. D., Assoc. M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Council House, Birmingham.
1889 Sept. 21	WATTS, E. T.	Surveyor to the Rural District Council, Hadham and Stansted, Bishop's Stortford.
1893 Oct. 21	WATTS, W., A.M.Inst. C.E. ..	Water Engineer, Langsett, near Penistone.
1899 Jan. 21	WEAVER, H. J.	Borough Surveyor, King's Lynn.
1887 June 18	WEAVER, W., M. Inst. C.E. (*President.*)	Borough Engineer, Kensington, W.
1900 Oct. 15	WEBB, H.	Surveyor to the Urban District Council, Halstead, Essex.
1897 Feb. 13	WEBB, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1895 May 25 R1901 Aug. 24	WEBSTER, R. J.	District Surveyor, Castleton, Manchester.
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1887 June 18 R1903 Feb. 21	WESTON, G.	The Limes, Harrow Road, Pinner.
1889 Apr. 13 R1903 Jan. 17	WESTON, H. J., Assoc. M. Inst. C.E.	24 Portland Street, Southampton.
1893 Apr. 22	WETHERILL, J. W.	Borough Surveyor, Richmond, Yorks.
1891 Oct. 17	WHITBREAD, R.	Surveyor to the Urban District Council, Carlton, Notts.
1888 July 12	WHITE, A. E., M. Inst. C.E. ..	City Engineer, Hull.
1891 Oct. 17	WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County. Ballybrophy.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
1899 Mar. 25	WHITTELL, F. S.	Surveyor to the Urban District Council, Worksop.
1900 Aug. 25	WHYATT, H. G. A. M. Inst. C.E.	Borough Engineer, Great Grimsby.

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Date of Election and Transfer.		
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1884 May 29 R1902 Nov. 8	WILKINSON, J. P.	301–304 Corn Exchange Chambers, Cathedral Street, Manchester.
1899 Feb. 25 R1903 Mar. 21	WILKINSON, W.	Ashton House, Hemingbrough, E. Yorks.
1899 Mar. 25	WILKINSON, M. H.	Surveyor to the Urban District Council, Leyland.
1884 Oct. 9 R1885 June 6	WILLCOX, J. E., Assoc. M. Inst. C.E.	63 Temple Row, Birmingham
1894 Mar. 3	WILLIAMS, H. DAWKIN	Surveyor to the Urban District Council, Ogmore and Garrw, Blackmill R.S.O., Bridgend.
1893 July 31	WILLIAMS, J. B.	Borough Surveyor, Daventry.
1896 Oct. 24	WILLIAMS, J.	Surveyor to the Urban District Council, Mountain Ash.
1897 May 15	WILLIAMS, M.	Surveyor to the Urban District Council, Bridgend.
1891 June 25	WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1898 June 30	WILSON, A.	County Surveyor, Dumbartonshire.
1887 Sept. 17	WILSON, G.	Surveyor to the Urban District Council, Alnwick.
1873 May 2 R1899 Feb. 25	WILSON, J.	Bankside, Bacup, Lancashire.
1884 May 29	*WILSON, J. B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cockermouth.
1900 Feb. 10	WILSON, V.	Surveyor to the Urban District Council, Wardle.
1887 May 7 R1903 Jan. 17	WINDOW, E. R., Assoc. M. Inst. C.E.	2 Church Street, Liverpool.
1897 Oct. 16	WINNING, D.	Burgh Surveyor, Broughty Ferry, N.B.
1880 Oct. 2	WINSHIP, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
1896 Feb. 22	WINTER, O. E., Assoc. M. Inst. C.E.	Borough Surveyor, Hampstead, N.W.
G1900 May 19 TA1902 Jan. 25 T1902 Nov. 8	*WOLFENDEN, B. J., A.M. Inst. C.E.	Borough Engineer, Bootle.
1880 Feb. 7	WOOD, A. R.	Surveyor to the Urban District Council, Tunstall.
1894 Mar. 3	WOOD, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.
1898 Apr. 23	WOOD, W. E.	Surveyor to the Urban District Council, Church.
1900 Feb. 10	WOODS, E. L.	Town Surveyor, Bangor, Co. Down.
1885 Oct. 3 R1903 Feb. 21	WOODBRIDGE, C. A.	Pinner House, Pinner, Middlesex.

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Date of Election and Transfer.		
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.
1897 July 8	*WORRALL, E.	Surveyor to the Urban District Council, Stretford, Council Offices, Old Trafford.
1886 July 8	WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
G1900 July 19 T1901 Oct. 19	*WOOTTON, A. S.	Borough Surveyor, South Molton, Devon.
G1893 July 13 T1899 Oct. 21	*WRIGHT, J. A.	Surveyor to the Urban District Council, Horfield.
1892 May 28	WYNNE-ROBERTS, R. O., Assoc. M. Inst. C.E.	City Hydraulic Engineer, Cape Town.
1895 Jan. 19	YABBICOM, T. H., M.Inst. C.E. (*Past President.*) (*Member of Council.*)	City Engineer, Bristol.
G1892 July 11 T1892 Sept. 24	*YATES, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
1894 June 21	YORK, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1900 May 19	YOUNG, J.	Borough Surveyor, Ayr.
1899 Dec. 16	YOUNG, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	YOUNG, W. P.	Surveyor to the Urban District Council, Hoyland Nether.

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TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

E. *signifies* EASTERN DISTRICT.
H. „ HOME DISTRICT.
I. „ IRISH DISTRICT.
L. & C. „ LANCASHIRE AND CHESHIRE DISTRICT.
Met. „ METROPOLITAN DISTRICT.
M. *signifies* MIDLAND DISTRICT.
N. „ NORTHERN DISTRICT.
S. „ SCOTTISH DISTRICT.
W. „ WELSH DISTRICT.
West „ WESTERN DISTRICT.
Y. „ YORKSHIRE DISTRICT.
A. *signifies* ABROAD.

TOWN.	DISTRICT.	NAME.
ABERCARNE	West	G. Stevens.
ABERDEEN	S.	W. Dyack.
ABERGAVENNY	West	J. Haigh.
ABINGDON	H.	G. Winship.
ABRAM	L. & C.	G. Heaton.
ACCRINGTON	L. & C.	W. J. Newton.
ACTON	H.	D. J. Ebbetts.
ALDEBURGH	E.	J. C. Gordon.
ALDERSHOT	H.	N. F. Dennis.
ALNWICK	N.	G. Wilson.
ALTRINCHAM	L. & C.	J. Stokoe.
ANDOVER	H.	R. W. Knapp.
ANNFIELD PLAIN	N.	T. J. Trowsdale.
ANTRIM (County)	I.	J. H. Brett.
ARMAGH	I.	J. C. Boyle.
„ (County)	I.	R. H. Dorman.
ASHBOURNE	M.	W. Stringfellow.
ASHBY-DE-LA-ZOUCH	M.	S. Turner.
ASHFORD	H.	W. Terrill.
ASHTON-UNDER-LYNE	L. & C.	J. T. Earnshaw.
ASHTON-ON-MERSEY	L. & C.	F. Hutton.
ASTON MANOR	M.	G. H. Jack.
ATHERTON	L. & C.	W. Clough.
„	L. & C.	F. H. Grimshaw.
AUDLEY	M.	T. Bibbey.
AYLESBURY	H.	J. H. Bradford.
AYR	S.	J. Young.
AYRSHIRE (County)	S.	A. Stevenson.
BALLYMENA	I.	H. O'Hara.
BANBURY	H.	N. H. Dawson.
BANGOR, Co. DOWN	I.	E. L. Woods.
BARKING	H.	C. F. Dawson.

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TOWN.	DISTRICT.	NAME.
Barnes	H.	G. B. Tomes.
Barrow-in-Furness	L. & C.	J. W. Smith.
Barry	W.	J. C. Pardoe.
Barton-upon-Irwell (Rural)	L. & C.	C. C. Hooley.
Basford (Rural)	M.	S. Maylan.
„ „ (Highways)	M.	G. W. Hawley.
Basingstoke (Rural)	H.	R. Forrester.
Beckenham	H.	J. A. Angell.
Bedford (County)	H.	W. H. Leete.
Bedlingtonshire	N.	C. Brown.
Belfast	I.	H. A. Cutler.
Belper	M.	T. Fenn.
„ (Rural)	M.	R. C. Cordon.
Benwell	N.	W. P. Pattison.
Bermondsey	Met.	R. J. Angel.
Berwick-on-Tweed	S.	R. Dickinson.
Beverley	Y.	J. G. Smith.
„ (Rural)	Y.	E. Picker.
Bexhill	H.	G. Ball.
Bexley	H.	W. T. Howse.
Biddulph	M.	S. Gibson.
Biggleswade	H.	T. Cockrill.
„ (Rural)	H.	J. O. Jones.
Bilston	M.	J. P. Wakeford.
Birkenhead	L. & C.	C. Brownridge.
Birmingham	M.	J. Price.
Bishop's Castle	M.	A. Hamar.
Bishop's Stortford	H.	R. S. Scott.
Blackburn	L. & C.	W. Stubbs.
Blackpool	L. & C.	J. S. Brodie.
Blackwell (Rural)	M.	H. Silcock.
Bloemfontein, South Africa	A.	H. F. Peet.
Blyth and Cuckney (Rural)	M.	F. Hopkinson.
Bognor	H.	O. A. Bridges.
Bombay	A.	M. C. Murzban.
„	A.	J. Hall.
Bootle	L. & C.	B. J. Wolfenden.
Bourne (Rural)	E.	A. J. Metcalfe.
Bournemouth	H.	F. W. Lacey.
Brackley	M.	A. A. Green.
Bradford	Y.	J. H. Cox.
Bradford-on-Avon	West	S. Howard.
Braintree	E.	H. H. Nankivell.
Branksome	West	S. J. Newman.
Bray	I.	P. F. Comber.
Brentford	H.	N. Parr.
Brentwood	E.	J. E. Fothergill.
Bridgend	W.	M. Williams.
Bridgwater	West	F. Parr.
Bridlington	Y.	E. R. Matthews.
„ (Rural)	Y.	S. Dyer.
Brierfield	L. & C.	J. T. Landless.
Brighouse	Y.	S. S. Haywood.
Brighton	H.	F. J. C. May.
Brisbane, Queensland	A.	J. Kemp.
Bristol	West	T. H. Yabbicom.
Briton Ferry	W.	H. A. Clarke.
Broadstairs	H.	H. Hurd.
Bromyard	M.	J. D. Barrs.
Broughty Ferry, N.B.	S.	D. Winning.

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TOWN.	DISTRICT.	NAME.
Brownhills	M.	W. B. Chancellor.
Brynmawr	W.	D. W. Slocombe.
Buckhurst Hill	E.	H. Tooley.
Buckingham	M.	J. Smith.
„ (County)	H.	R. J. Thomas.
Bucklow (Rural)	L. & C.	J. McD. McKenzie.
Burnham	West	W. J. Press.
Burnley	L. & C.	G. H. Pickles.
„ (Rural)	L. & C.	S. Edmondson.
Burslem	M.	F. Bettany.
Burton-on-Trent	M.	G. T. Lynam.
Bury	L. & C.	A. W. Bradley.
Bury St. Edmunds	E.	W. D. Harding.
Buxton	M.	W. H. Grieves.
Caerphilly	W.	A. O. Harpur.
Calcutta	A.	T. C. Deverell.
Camberwell	Met.	W. Oxtoby.
Cannock, Staffs	M.	J. S. Hendry.
Canterbury	H.	A. C. Turley.
Cape Town, South Africa	A.	J. Cook.
Cardiff	W.	W. Harpur.
Carlisle	N.	H. C. Marks.
Carlton	M.	R. Whitbread.
Carmarthen	W.	F. J. Finglah.
Carnarvonshire (County)	W.	E. Evans.
„ (Borough)	W.	E. Hall.
Castleford	Y.	W. Green.
Caversham	H.	S. P. Andrews.
Chatham	H.	C. Day.
Chelmsford (Rural)	E.	J. Dewhirst.
Chelsea	Met.	T. W. E. Higgens.
Cheltenham	West	J. S. Pickering.
Chepstow	W.	F. Feather.
Cheriton	H.	C. Vawser.
Chertsey	H.	J. F. Stow.
Chesham	H.	P. C. Dormer.
Cheshire (County)	L. & C.	H. F. Bull.
Cheshunt	H.	R. H. Jeffes.
Chester	L. & C.	I. M. Jones.
Chesterfield (Rural)	M.	E. Lines.
Chesterton	E.	J. D. Bland.
„ (Rural)	E.	J. Dunn.
Chichester	H.	I. Pym-Jones.
Chippenham	West	A. E. Adams.
Chiswick	H.	J. Barclay.
Chorley	L. & C.	W. Leigh.
Christchurch	H.	E. I. Legg.
Church	L. & C.	W. E. Wood.
Clacton-on-Sea	E.	A. R. Robinson.
Claypole (Rural)	E.	C. D. M. Trinder.
Clayton-le-Moors	L. & C.	A. Dodgeon.
Cleckheaton	Y.	C. Lund.
Clethorpes	E.	E. Rushton.
Coalville	M.	L. L. Baldwin.
Coburg, Victoria	A.	W. M. Pullar.
Cockermouth (Rural)	N.	J. B. Wilson.
Colchester	E.	H. Goodyear.
Colne	L. & C.	T. H. Hartley.

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TOWN.	DISTRICT.	NAME.
Colombo, Ceylon	A.	F. A. Cooper.
„ „	A.	R. Skelton.
Colwyn Bay	W.	W. Jones.
Congleton	L. & C.	R. Burslam.
Conway (Rural)	W.	T. B. Farrington.
Cookham (Rural)	H.	F. Laurens.
Cork (County), West	I.	R. W. Longfield.
„ „ South	I.	S. A. Kirkby.
Cottingham	Y.	J. H. Hanson.
Cowes, Isle of Wight	H.	J. W. Webster.
Cowpen	N.	R. Grieves.
Crewe	L. & C.	G. Eaton-Shore.
Cromer	E.	A. F. Scott.
Croydon	H.	G. F. Carter.
„ (Highways)	H.	E. F. Morgan.
„ (Rural) (Highways)	H.	S. Stallard.
„ (Rural)	H.	R. M. Chart.
Cumberland (County)	N.	G. J. Bell.
Cupar (Fife) (County)	S.	T. Aitken.
Dartford	H.	W. Harston.
Dartmouth	West	A. Smith.
Daventry	M.	J. B. Williams.
Darwen	L. & C.	R. W. Smith-Saville.
Deal	H.	T. C. Golder.
Denton	L. & C.	G. H. Newton.
Derby	M.	J. Ward.
„ (County)	M.	J. S. Story.
Desborough	M.	D. J. Diver.
Devon (County)	West	W. Ingham.
Dewsbury	Y.	H Dearden.
Doncaster (Rural) (Highways)	Y.	W. Crabtree.
„ (Rural)	Y.	C. C. Barras.
Dorchester	West	G. J. Hunt.
Dorking	H.	G. S. Mathews.
„ (Rural)	H.	W. Rapley.
Douglas, Isle of Man	L. & C.	A. E. Prescott.
Dover	H.	H. E. Stilgoe.
Down (County)	I.	J. Heron.
Driffield (Rural)	Y.	T. C. Beaumont.
Droitwich	M.	T. P. Baylis.
Droylsden	L. & C.	C. Hall.
Dublin	I.	S. Harty.
„ (County)	I.	W. Collen.
Dudley	M.	J. Gammage.
Dukinfield	L. & C.	S. Hague.
Dumbartonshire (County)	S.	A. Wilson.
Dunfermline (County)	S.	D. MacKenzie.
Dunstable	M.	G. Simcox.
Durham (Rural)	N.	G. Gregson.
Ealing	H.	C. Jones.
East Barnet Valley	H.	H. York.
East Ham	H.	A. H. Campbell.
East London, Cape Colony	A.	W. A. Palliser.
East Molesey	H.	J. Stevenson.
East Retford (Rural)	M.	T. Henry.
East Stow (Rural)	E.	G. F. P. Harrison.

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TOWN.	DISTRICT.	NAME.
Eastbourne	H.	D. J. Bowe.
Ebbw Vale	W.	T. J. Thomas.
Elgin, N.B.	S.	A. A. Turriff.
Enfield	H.	R. Collins.
Epsom	H.	E. R. Capon.
Erdington	M.	H. H. Humphries.
Erith	H.	H. Hind.
Eston	Y.	C. McDermid.
Eton (Rural)	H.	R. Hallam.
„ „ (Highways)	H.	A. Gladwell.
Evesham	M.	R. C. Mawson.
Exeter	West	T. Moulding.
Exmouth	West	S. Hutton.
Falmouth	West	W. H. Tressider.
Fareham	H.	W Butler.
Farnborough	H.	J. E. Hargreaves.
Farnham	H.	R. W. Cass.
Featherstone	Y.	F. B. Rothera.
Felixstowe	H.	S. E. Fisher.
Fenny Stratford	H.	J. Chadwick.
Finchley	H.	C. J. Jenkin.
Finsbury	Met.	P. G. Killick.
Flintshire (County)	W.	S. Evans.
Folkestone	H.	A. E. Nichols.
Foot's Cray	H.	W. A. Farnham.
Friern Barnet	H.	E. J. Reynolds.
Frome	West	P. Edinger.
Gainsborough	E.	R. W. Fraser.
Galway (County), West	I.	J. Perry.
„ „ East	I.	J. Smith.
Glamorgan (County)	W.	T. L. Edwards.
Glasgow	S.	A. B. McDonald.
Glastonbury	West	G. Alves.
Gloucester	West	R. Read.
„ (County)	West	R. Phillips.
Glyncorrwg	W.	W. P. Jones.
Godalming	H.	J. H. Norris.
Godstone (Rural)	H.	J. G. Powell.
Gorton	L. & C.	C. J. Lomax.
Gosforth	N.	C. J. Baff.
Gosport and Alverstoke	H.	H. Frost.
Grantham	E.	F. J. Morris.
Gravesend	H.	F. T. Grant.
Grays Thurrock	H.	A. C. James.
Great Crosby	L. & C.	W. Hall.
Great Grimsby	E.	H. G. Whyatt.
Great Yarmouth	E.	J. W. Cockrill.
Grey County, New Zealand	A.	J. Higgins.
Greymouth, New Zealand	A.	E. I. Lord.
Guernsey	H.	T. J. Guilbert.
Guildford	H.	C. G. Mason.
„ (Rural)	H.	J. Anstee.
Guiseley	Y.	J. C. Haller.

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TOWN.	DISTRICT.	NAME.
Hackney	Met.	N. Scorgie.
Hadham and Stanstead	H.	E. T. Watts.
Hailsham (Rural)	H.	J. Huxley.
Hale	L. & C.	F. Lobley.
Halifax (Rural)	Y.	F. Gordon.
Halstead	E.	H. Webb.
Hammersmith	Met.	H. Mair.
Hampstead	Met.	O. E. Winter.
Hampton-on-Thames	H.	S. H. Chambers.
Hampton Wick	H.	J. N. Horsfield.
Handsworth	M.	H. Richardson.
Hanley	M.	J. Lobley.
Hants (County)	H.	W. J. Taylor.
Hanwell	H.	S. W. J. Barnes.
Harrow	H.	J. P. Bennetts.
Harwich	E.	H. Ditcham.
Haslingden	L. & C.	J. S. Green.
Hastings	H.	P. H. Palmer.
Haverhill	E.	F. W. Knewstubb.
Hebden Bridge	Y.	W. Calvert.
Heckmondwike	Y.	J. Saville.
Hemel Hempstead	M.	W. R. Locke.
Hendon	H.	S. S. Grimley.
„ (Rural)	H.	J. A. Webb.
Hengoed *viâ* Cardiff (Rural)	W.	J. P. Jones.
Henley-on-Thames	H.	R. Pratt.
Hereford	M.	J. Parker.
„ (County)	M.	A. Dryland.
Herne Bay	H.	F. W. J. Palmer.
Hertford	H.	J. H. Jevons.
Heysham	L. & C.	H. Miller.
Heywood	L. & C.	J. A. Settle.
High Wycombe	H.	T. J. Rushbrooke.
Hinckley	M.	E. H. Crump.
Hitchin	H.	A. T. Blood.
Holborn	Met.	G. Wallace.
Holyhead	W.	A. Asquith.
Horfield	West	J. A. Wright.
Hornsey	H.	E. J. Lovegrove.
Horsforth	Y.	R. R. Jones.
Horsham	H.	R. Renwick.
Hove	H.	H. H. Scott.
Howrah, Bengal	A.	A. Hale.
Hoylake and West Kirby	L. & C.	T. Foster.
Hoyland Nether	Y.	W. P. Young.
Huddersfield	Y.	K. F. Campbell.
„ (Gas)	Y.	E. A. Harman.
Hull	Y.	A. E. White.
Huntingdon (County)	M.	H. J. G. Leete.
Hyde	L. & C.	J. Mitchell.
Hythe	H.	Chris. Jones.
Ilford	E.	H. Shaw.
Ilfracombe	West	O. M. Prouse.
Ipswich	E.	E. Buckham.
Ipswich, Queensland	A.	T. Kirk.
Isle of Ely, north (County)	E.	H. F. Simpson.
Isle of Thanet (Rural)	H.	F. T. Elliott.
Isle of Wight (County)	H.	F. Newman.

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TOWN.	DISTRICT.	NAME.
Islington	Met.	J. P. Barber.
Itchen	H.	T. A. Collingwood.
Kearsley	L. & C.	H. Nuttall.
Keighley	Y.	W. H. Hopkinson.
Kendal	N.	R. H. Clucas.
Kensington	Met.	W. Weaver.
Kent (County)	H.	F. W. Ruck.
Kesteven (County)	E.	W. B. Purser.
Keswick	N.	W. Hodgson.
Kettering	M.	T. R. Smith.
Keynsham (Rural)	West	H. M. Bennett.
Kidderminster (Rural)	M.	A. Comber.
Kilkenny (County)	I.	A. M. Burden.
King's Lynn	E.	H. J. Weaver.
King's Norton	M.	A. W. Cross.
Kingston (Highways)	H.	A. J. Henderson.
Kingston, Jamaica	A.	C. V. Abrahams.
Kirkcaldy	S.	J. L. Lumsden.
Lancashire (County)	L. & C.	W. H. Schofield.
Lancaster	L. & C.	J. . . Mount.
Lanchester (Rural) (Highways)	N.	W. Cumming.
Leatherhead	H.	T. Salkield.
Leeds	Y.	T. Hewson.
Leek	M.	W. E. Beacham.
Leicester	M.	E. G. Mawbey.
„ (County)	M.	S. P. Pick.
Leigh	L. & C.	T. Hunter.
„ (Rural)	L. & C.	T. W. B. Gent.
Leigh-on-Sea	E.	W. J. Petch.
Leighton Buzzard	H.	J. Stewart.
Leith	S.	W. Beatson.
Leitrim (County)	I.	E. O'N. Clarke.
Levenshulme	L. & C.	J. Jephson.
Lewes	H.	D. Roberts.
Leyland	L. & C.	W. H. Wilkinson.
Leyton	H.	W. Dawson.
Limehurst (Rural)	L. & C.	H. H. Turner.
Limerick (County)	I.	J. Horan.
Lincoln	E.	R. A. MacBrair.
„ (County)	E.	J. Thropp.
Litherland	L. & C.	A. H. Carter.
Littleborough	L. & C.	G. H. Wild.
Littlehampton	H.	H. Howard.
Liverpool	L. & C.	J. A. Brodie.
Llandaff (Rural) (Highways) ..	W.	J. Holden.
Llandudno	W.	E. P. Stephenson.
Llanelly	W.	G. Watkeys.
Llantrissant (Rural)	W.	G. S. Morgan.
Loftus	Y.	T. H. Tarbit.
London	Met.	D. J. Ross.
„ (County)	Met.	M. Fitzmaurice.
Londonderry	I.	W. J. Robinson.
Long Crendon (Rural)	H.	A. J. Dickinson.
Longford (County)	I.	J. W. Gunnis.
Longton	M.	J. W. Wardle.
Loughborough	M.	A. H. Walker.

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TOWN.	DISTRICT.	NAME.
Louth (County)	I.	P. J. Lynam.
Lower Bebington	L. & C.	H. W. Corrie.
Lowestoft	E.	G. H. Hamby.
Lurgan	I.	H. Shillington.
Luton	H.	A. J. L. Evans.
Lymington	H.	J. Stansfield-Brun.
Lynton	West	W. H. Chowins.
Lytham	L. & C.	A. J. Price.
Macclesfield	L. & C.	E. E. Adshead.
„ (Rural)	L. & C.	J. Thorpe.
Maesteg	W.	J. Humphreys.
Maidstone	H.	T. F. Bunting.
„ (Rural)	H.	J. S. Killick.
Maldon	E.	T. R. Swales.
„ (Rural)	E.	H. G. Keywood.
Malvern	M.	H. P. Maybury.
Manchester	L. & C.	T. De C. Meade.
Mansfield	M.	R. F. Vallance.
Mansfield Woodhouse	M.	F. P. Cook.
Margam, Port Talbot	W.	J. Cox.
Margate	H.	E. A. Borg.
Market Harborough	M.	H. G. Coales.
Marylebone	Met.	J. A. P. Waddington.
Matlock	M.	J. Diggle.
Matlock Bath	M.	W. Jaffrey.
Meath (County)	I.	J. H. Moore.
Melbourne	A.	W. Thwaites.
Melrose, New Zealand	A.	L. G. Spencer.
Melton Mowbray	M.	E. Jeeves.
Menai Bridge	W.	R. A. Thomas.
Merthyr Tydvil	W.	T. F. Harvey.
Methley	Y.	T. W. Nichols.
Mexborough	Y.	G. F. Carter.
Middlesbrough	Y.	F. Baker.
Middlesex (County)	H.	H. T. Wakelam.
Middleton	L. & C.	W. Welburn.
Midhurst (Rural)	H.	A. G. Gibbs.
Midsomer Norton	West.	W. F. Bird.
Milton-next-Sittingbourne	H.	A. R. Warren.
Monmouthshire (County)	W.	W. Tanner.
Montgomery	W.	W. P. Hole.
Morley	Y.	W. E. Putman.
Mountain Ash	W.	J. Williams.
Nantwich	L. & C.	W. F. Newey.
Nantyglo and Blaina	W.	W. J. Davies.
Neath	W.	D. M. Jenkins.
„ (Rural)	W.	W. E. C. Thomas.
Nelson	L. & C.	B. Ball.
Neston	L. & C.	C. E. Senior.
New Malden	H.	T. B Simmonds.
New Swindon	H.	H. J. Hamp.
Newark	M.	G. Sheppard.
„ (Rural)	M.	R. Oakden.
Newburn-on-Tyne	N.	T. Gregory.
Newbury	H.	S. J. L. Vincent.

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TOWN.	DISTRICT.	NAME.
Newcastle-on-Tyne	N.	F. J. Edge.
Newhaven	H.	F. J. Rayner.
Newmarket	E.	J. W. Metcalf.
Newport, Mon.	West	R. H. Haynes.
Newton Abbot	West	L. Stevens.
Newtown St. Boswells, N.B. ..	S.	G. Monteath.
Norfolk (County)	E.	T. H. B. Heslop.
North Mayo (County)	I.	W. P. Orchard.
Northallerton	Y.	D. Hinchcliffe.
Northampton	M.	A. Fidler.
Northumberland (County) ..	N.	J. A. Bean.
Northwich	L. & C.	J. Brooke.
Norwich	E.	A. E. Collins.
Nottingham	M.	A. Brown.
,, (County)	M.	E. P. Hooley.
Nuneaton	M.	F. C. Cook.
Oakworth	Y.	J. Spencer.
Ogmore and Garrew	W.	H. D. Williams.
Okehampton	West	H. Geen.
Oldbury	M.	T. H. Shipton.
Oldham	L. & C.	S. A. Pickering.
Oswestry	M.	G. W. Lacey.
Otley	Y.	J. E. Sharp.
Oxford	H.	W. H. White.
Oystermouth	W.	M. Hoskins.
Paddington	Met.	E. B. Newton.
Padiham	L. & C.	J. Gregson.
Partick	S.	J. Bryce.
Peebles (County)	S.	R. S. Anderson.
Pemberton	L. & C.	G. Heaton.
Penang, Straits Settlements	A.	S. Reid.
Penarth	W.	E. I. Evans.
Penrith	N.	J. J. Knewstubb.
Perry Barr	M.	H. H. Gammell.
Perth, N.B.	S.	R. McKillop.
Perth, West Australia	A.	H. T. Haynes.
Peterborough	M.	J. W. Walshaw.
Plymouth	West	J. Paton.
Pokesdown	H.	E. W. Ingamells.
Pontardawe (Rural)	W.	J. Morgan.
Pontefract	Y.	J. E. Pickard.
Pontypridd	W.	E. Rees.
Poole	West	J. Elford.
Port Elizabeth, South Africa	A.	A. S. Butterworth.
Portishead	West	F. H. Smith.
Portslade-by-Sea	H.	A. T. Allen.
Portsmouth	H.	P. Murch.
Prahran, Victoria	A.	W. Calder.
Prescot	L. & C.	W. Goldsworth.
Prestwich	L. & C.	W. Nuttall.
Queen's County	I.	H. V. White.
Queenstown, South Africa ..	A.	W. A. Palliser.

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TOWN.	DISTRICT.	NAME.
Ramsgate	H.	T. G. Taylor.
Rangoon	A.	J. Stirrat.
Rawtenstall	L. & C.	A. W. Lawson.
Redcar	Y.	J. Howcroft.
Redditch	M.	B. Perrins.
Redruth	West	T. C. Jones.
Reigate	H.	F. T. Clayton.
Retford	M.	J. D. Kennedy.
Rhondda	W.	W. J. Jones.
Rhymney	W.	W. L. Marks.
Richmond, Surrey	H.	J. H. Brierley.
Richmond, Yorks	Y.	J. W. Wetherill.
Rochdale	L. & C.	S. S. Platt.
Rochester	H.	W. Banks.
Rochford (Rural)	H.	H. T. Sidwell.
Romford (Rural)	E.	E. G. Boden.
Roscommon (County)	I.	C. J. Mulvany.
Rotherham	Y.	G. Jennings.
,, (Rural)	Y.	B. Godfrey.
Rothwell, Northants	M.	W. T. Pearson.
Rowley Regis	M.	W. H. Brettell.
Rugeley	M.	W. E. Rogers.
Runcorn	L. & C.	J. Wilding.
,, (Rural)	L. & C.	W. Diggle.
Rushden	M.	W. B. Madin.
Ryton-on-Tyne	N.	J. P. Dalton.
Saffron Walden	E.	A. H. Forbes.
St. Albans	H.	G. Ford.
St. Helen's, Lancs.	L. & C.	G. J. C. Broom.
,, Isle of Wight	H.	J. I. Barton.
St. Pancras	Met.	W. N. Blair.
Sale	L. & C.	W. Holt.
Salford	L. & C.	J. Corbett.
Saltburn-by-the-Sea	Y.	G. S. L. Bains.
Sandgate	H.	A. R. Bowles.
Scarborough	Y.	H. W. Smith.
Sevenoaks	H.	S. Towlson.
Shanghai, China	A.	C. Mayne.
Shanklin	H.	E. C. Cooper.
Sheffield	Y.	C. F. Wike.
Sherborne	West	T. Farrall.
Shoreditch	Met.	J. R. Dixon.
Shrewsbury	M.	W. C. Eddowes.
Shropshire (County)	M.	A. T. Davis.
Singapore	A.	R. Peirce.
Skelton-in-Cleveland	Y.	W. P. Robinson.
Skipton	Y.	J. Mallinson.
,, (Rural)	Y.	A. Rodwell.
Sleaford	E.	J. Clare.
Slough	H.	W. W. Cooper.
Smallthorne	M.	J. Deane.
Smethwick	M.	C. J. Fox-Allin.
Solihull (Rural)	M.	A. E. Currall.
Soothill Upper	Y.	J. Blackburn.
South Molton	West	A. S. Wootton.
South Shields	N.	S. E. Burgess.
Southall Norwood	H.	R. Brown.

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TOWN.	DISTRICT.	NAME.
Southampton	H.	J. A. Crowther.
Southend-on-Sea	H.	E. J. Elford.
Southgate	H.	C. G. Lawson.
Southowram	Y.	W. H. D. Horsfall.
Southport	L. & C.	R. P. Hirst.
Southwark	Met.	A. Harrison.
Southwick-on-Wear	N.	W. B. Thomas.
Spalding (Rural)	E.	T. J. Peacock.
Spilsby (Rural)	E.	T. A. Busbridge.
Stafford	M.	W. Blackshaw.
„ (County) (Highways)	M.	J. Moncur.
Staines	H.	E. J. Barrett.
„ (Rural)	H.	G. W. Manning.
Stalybridge	L. & C.	J. N. White.
Stamford	E.	J. Richardson.
Stepney	Met.	M. W. Jameson.
Stirling	S.	A. H. Gondie.
Stirlingshire (Highways)	S.	R. M. Reid.
Stockport	L. & C.	J. Atkinson.
Stockton-on-Tees	N.	M. H. Sykes.
Stoke-on-Trent	M.	A. Burton.
Stoke Newington	Met.	W. F. Loveday.
Stone	M.	A. R. Ridout.
Stourbridge	M.	F. Woodward.
Stratford-on-Avon	M.	R. Dixon.
Stretford	L. & C.	E. Worrall.
Strood (Rural)	H.	W. Brooke.
Stroud	West	G. P. Milnes.
Sudbury, Suffolk	E.	T. W. A. Hayward.
Suffolk (County), East	E.	H. Miller.
Sunbury-on-Thames	H.	H. F. Coales.
Sunderland (Rural)	N.	T. Young.
Surrey (County)	H.	F. G. Howell.
Sussex (County), East	H.	F. J. Wood.
Sutton	H.	C. C. Smith.
Sutton Coldfield	M.	W. A. H. Clarry.
Sutton-in-Ashfield	M.	McW. Bishop.
Swadlincote	M.	T. Kidd.
Swanage	West	J. S. Senior.
Swansea	W.	G. Bell.
Swinton	L. & C.	H. Entwisle.
Sydney, New South Wales	A.	J. M. Smail.
Tadcaster (Rural)	Y.	T. Scott.
Tamworth	M.	F. E. G. Bradshaw.
„ (Rural)	M.	H. J. Clarson.
Tanfield	N.	R. Heslop.
Teddington	H.	M. Hainsworth.
Teignmouth	West	V. Smith.
Tenbury (Rural)	M.	R. W. Jarvis.
Tenby	W.	J. P. James.
Tettenhall	M.	J. Mortimer.
Tewkesbury	West	W. Ridler.
Thornhill	Y.	S. W. Parker.
Tientsin, China	A.	A. W. H. Bellingham.
Tipperary (County), South	I.	E. A. Hackett.
Tipton	M.	W. H. Jukes.

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TOWN.	DISTRICT.	NAME.
Tiverton	West	J. Siddalls.
Todmorden	Y.	C. R. Pease.
Tokio Fu, Japan	A.	R. Hara.
Tonbridge	H.	W. L. Bradley.
„ (Rural)	H.	F. Harris.
Toowong, Queensland	A.	W. E. Irving.
Tottenham	H.	W. H. Prescott.
Towyn	W.	R. P. Morgan.
Trowbridge	West	H. G. N. Lailey.
Truro	West	M. Lea.
Tunbridge Wells	H.	W. H. Maxwell.
Tunstall	M.	A. R. Wood.
Turton	L. & C.	V. Laithwaite.
Twickenham	H.	F. W. Pearce.
Tyldesley	L. & C.	J. B. Smith.
Tynemouth	N.	J. F. Smillie.
Tyrone (County), North	I.	F. J. Lynam.
„ „ South	I.	J. W. Leebody.
Ulverston (Rural)	L. & C.	W. F. Y. Molineux.
Urmston	L. & C.	J. Heath.
Uxbridge (Rural) (Highways)	H.	E. Birks.
„ (Rural)	H.	J. F. Stow.
Wakefield	Y.	R. Porter.
„ (Rural)	Y.	F. Massie.
Wallasey	L. & C.	W. H. Travers.
Walsall	M.	R. H. Middleton.
„ (Rural)	M.	F. W. Mager.
Waltham Cross	E.	W. T. Streather.
Walthamstow	H.	G. W. Holmes.
Wandsworth (Eastern)	Met.	H. J. Marten.
„ (Western)	Met.	P. Dodd.
Wanstead	H.	J. T. Bressey.
Wantage (Rural)	H.	W. Hanson.
Wardle	L. & C.	V. Wilson.
Ware	H.	J. E. Smales.
Warminster	West	C. H. Lawton.
Warrnambool, Melbourne	A.	J. C. Ross.
Warwickshire (County)	M.	J. Willmot.
Waterford	I.	M. J. Fleming.
„ (County)	I.	W. E. L. Duffin.
Waterloo	L. & C.	F. S. Yates.
Watford	H.	D. Waterhouse.
Wath-upon-Dearne	Y.	H. C. Poole.
Wealdstone	H.	F. H. Parr.
Wellington, New Zealand	A.	R. S. Rounthwaite.
Wembley	H.	C. R. W. Chapman.
West Bromwich	M.	A. D. Greatorex.
West Hartlepool	N.	J. W. Brown.
West Malling (Rural)	H.	J. Marshall.
Westminster	Met.	J. W. Bradley.
Weston-super-Mare	West	H. Nettleton.
Westport, Co. Mayo	I.	M. A. Moynihan.

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TOWN.	DISTRICT.	NAME.
Weymouth and Melcombe Regis	West	W. B. Morgan.
Whitchurch	M.	M. Sowden.
Whitehaven	N.	E. E. Stiven.
Widnes	L. & C.	J. S. Sinclair.
Wigtownshire (Highways) ..	S.	J. D. Smith.
Willenhall	M.	T. E. Fellows.
Willesden	H.	O. C. Robson.
Willington Quay	N.	J. F. Davidson.
Wilmslow	L. & C.	A. S. Cartwright.
Wimbledon	H.	C. H. Cooper.
Winchester	H.	W. V. Anderson.
„ (Rural)	H.	G. E. Carter.
Windermere	L. & C.	C. E. Hines.
Windsor	H.	E. A. Stickland.
Winton	H.	J. H. Scott.
Wisbech	E.	A. H. Plowright.
Withington	L. & C.	A. H. Mountain.
Witney	H.	G. A. Graham.
Wokingham	M.	C. W. Marks.
Wolverhampton	M.	G. Green.
Wood Green	H.	C. J. Gunyon.
Woodford	E.	W. Farrington.
Woolwich	M.	F. Sumner.
Worcester	M.	T. Caink.
„ (County)	M.	J. H. Garrett.
Worksop	M.	F. S. Whittell.
Worsley	L. & C.	J. T. Proffitt.
Worthing	H.	F. Roberts.
Wortley (Rural)	Y.	G. E. Beaumont.
Wrexham	W.	J. W. M. Smith.
„ (Rural)	W.	J. P. Evans.
York	Y.	A. Creer.
Yorkshire, East Riding	Y.	A. Beaumont.
„ West Riding	Y.	J. V. Edwards.
„	Y.	W. G. Bryning.

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ASSOCIATES.

* *Those Associates against whose names a star is placed have obtained the certificate of the Association.*

G *signifies elected as Graduate.*
TA *transferred to Associate Class.*

Date of Election and Transfer.				
1901	Oct.	19	ASHBEE, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1902	Jan.	25	*BELL, L. M., A.M. Inst. C.E.	Assistant Engineer, Municipal Offices, Singapore, S.S.
G1897	July	31	*BENTLEY, J. H., A. M. Inst.	Chief Engineering Assistant,
TA1901	Oct.	19	C.E.	Town Hall, Oldham.
G1898	June	30	*BEST, H. Storr	Assistant Engineer, Council
TA1901	Oct.	19		Offices, Beckenham, S.E.
G1893	June	24	*BIRCH, J.	Deputy Surveyor, Public Offices,
TA1902	Nov.	8		East Ham.
G1897	June	9	*BISSELL, W. S.	Assistant Borough Surveyor,
TA1901	Dec.	7		Wolverhampton.
1903	Jan.	17	*BOOTH, E. W.	Engineering Assistant, Town Hall, Croydon.
G1898	June	30	*BRISCOE, J. T.	Deputy Engineer, Council
TA1903	June	25		Offices, Enfield.
1903	July	25	*BROMLY, A.	Assistant Engineer, Town Hall, Croydon.
1902	Jan.	25	BROOKES, A. E.	Assistant County Surveyor, Worcester C.C. Breedon Cross, King's Norton, Birmingham.
1902	Jan.	25	BROWN, H. A.	Assistant Borough Surveyor, Town Hall, Fulham, S.W.
G1899	Jun.	29	*BUSH, W. E., ...	Borough Engineer, Sudbury,
TA1902	Jan.	25		Suffolk.
G1892	July	11	*CARTER, G. F., A.M. Inst. C.E.	Borough Engineer, Croydon.
TA1901	Dec.	7		
G1895	May	25	*CLARK, A. H. F.	District Engineer, P.W.D.,
TA1902	May	10		Ceylon.
1902	May	10	CLARK, G. E.	District Surveyor, Town Hall, Sheffield.
G1890	Sept.	13	*CATCHPOLE, H.	Chief Assistant Engineer,
TA1902	Sept.	6		Council Offices, Finchley.
G1898	Dec.	17	*CLEWS, C. A.	Engineering Assistant, Borough
TA1902	Mar.	22		Surveyor's Office, Derby.
1903	May	16	COOKE, J. E.	Assistant Borough Engineer, Town Hall, Islington.
G1900	May	19	*COOMBS, C. A.	Engineering Assistant, Town
TA1901	Oct.	19		Hall, Burton-on-Trent.
G1899	June	29	*COLLINGE, T. P., A.M. Inst. C.E.	Chief Engineering Assistant,
TA1902	Jan.	25		Town Hall, Nelson.
G1897	Feb.	13	*COLLIS-ADAMSON, A. C. ..	Engineering Assistant, Council
TA1901	Oct.	19		Offices, Hornsey, N.
G1899	Oct.	21	*COWAN, G.	District Surveyor, Town Hall,
TA1902	Nov.	8		Portsmouth.
G1901	Aug.	24	*COX, A. L.	City Surveyor's Office, Man-
TA1901	Oct.	19		chester.

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Date of Election and Transfer.			
1901 Oct. 19		*Croxford, C. H.	Chief Engineering Assistant, Town Hall, Wood Green, N.
1902 Jan. 25		Crook, W. E.	Chief Engineering Assistant, Middlesex C.C. Guildhall, Westminster.
c1891 Sept. 12		*Dolamore, F. P.	Deputy Borough Engineer,
TA1902 Sept. 6			Bournemouth.
c1898 Dec. 17		*Ellison, D.	Deputy Borough Engineer,
TA1901 Dec. 7			West Bromwich.
c1898 Feb. 19		*Endsor, H. A.	Surveyor, Rural District Council,
TA1902 Jan. 25			Keynsham, Bristol.
c1896 June 25		*Fell, P. O.	Deputy City Engineer, Norwich.
TA1901 Dec. 7			
c1899 Oct. 21		*Foster, H. H.	Assistant Surveyor, Borough
TA1903 July 25			Surveyor's Office, Wandsworth. 215 High Rd., Balham.
c1901 June 8		*Fowlds, W., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Keighley.
TA1901 Oct. 19			
c1901 May 11		*Gair, J.	Assistant Borough Surveyor,
TA1902 Jan. 25			Town Hall, Hammersmith, W.
1903 Mar. 21		Galbraith, A. R., A.M. Inst. C.E.	District Surveyor, Town Hall, Portsmouth.
c1898 Jan. 15		*Godfrey, C. H., A.M. Inst. C.E.	Chief Engineering Assistant,
TA1903 Jan. 17			Municipal Offices, Shanghai.
c1899 Dec. 16		*Goodfellow, H.	Chief Engineering Assistant,
TA1902 May 10			Town Hall, Southport.
c1894 Jan. 13		*Gordon, J., A.M. Inst. C.E.	Assistant Burgh Surveyor,
TA1902 July 10			Aberdeen.
1903 July 25		Gray, A. R.	Engineering Assistant, Council House, Birmingham.
1901 Dec. 7		Greenshields, N., A.M. Inst. C.E.	Borough Engineer, Bedford.
c1893 Jan. 14		*Greenwood, J. P., A.M. Inst.	Deputy Borough Surveyor,
TA1901 Oct. 19		C.E.	Town Hall, Burnley.
1902 Mar. 22		Hadfield, W. J.	Chief Assistant, Town Hall, Sheffield.
c1897 June 19		*Haigh, W. H., A.M. Inst. C.E.	Engineering Assistant, Borough
TA1901 Oct. 19			Engineer's Office, Town Hall, Cardiff.
1903 June 6		Harding, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
c1899 Oct. 21		*Harper, A.	Deputy Borough Surveyor,
TA1902 May 10			Town Hall, St. Helen's, Lancs.
1903 June 6		Heap, H., A.M. Inst. C.E. ..	Deputy Borough Engineer, Great Grimsby.
c1900 Mar. 10		*Hinchcliff, E. R...	Deputy Surveyor, Council
TA1902 May 10			Offices, Barry.
c1900 Aug. 25		*Holloway, W. C.	Chief Engineering Assistant,
TA1902 Mar. 22			Council Offices, Kettering.
1902 Feb. 22		Horton, J.. W., A.M. Inst. C.E.	County Surveyor's Office, Hatfield, Herts.
c1895 July 27		*Jenkins, A. J., A.M. Inst. C.E.	Deputy Borough Engineer,
TA1902 Jan. 25			Town Hall, Burton-on-Trent.
c1897 July 31		*Jenkins, R. J.	District Surveyor, Town Hall,
TA1902 Nov. 8			Portsmouth.

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Date of Election and Transfer.		
G1900 June 16 TA1901 Oct. 19	*Jerram, G., A.M. Inst. C.E.	Assistant Surveyor, Town Hall, Walthamstow, N.E.
G1897 June 19 TA1902 Jan. 25	*Johnston, R. W.	Deputy Borough Engineer, Town Hall, Birkenhead.
1902 May 10	Ker, A. M., A.M. Inst. C.E.	Assistant Borough Engineer, Town Hall, Warrington.
1902 Mar. 22	Lancashire, W. T.	Deputy City Surveyor, Town Hall, Sheffield.
1901 Dec. 7	Lashmore, E. W...	District Surveyor, 63 Queen Square, Bristol.
G1901 May 11 TA1901 Oct. 19	*Lismer, A. B.	Engineering Assistant, Town Hall, Croydon.
1902 Nov. 8	McKenzie, L. S., A.M.Inst.C.E.	District Surveyor, 63 Queen Square, Bristol.
1903 Mar. 21	Manning, W. R., A.M. Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.
1903 Jan. 17	Marshall, L. P., A.M. Inst. C.E.	Northern Outfall Works, Beckton, E.
G1900 Apr. 21 TA1901 Dec. 7	*Miller, G. F.	Chief Assistant, Borough Engineer's Office, Hastings.
G1898 Dec. 17 TA1901 Oct. 19	*Mitchell, G.	Font Reservoir, near Ewesley, Northumberland.
G1901 Aug. 24 TA1902 Nov. 8	*Neave, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
1902 Jan. 25	Oakes, H. H...	Assistant Borough Engineer, Town Hall, Bridlington.
G1895 June 27 TA1902 July 10	*Openshaw, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
G1900 June 16 TA1902 Feb. 22	*Percival, W.	Assistant Borough Surveyor, Court House, Longton, Staffs.
G1895 Jan. 19 TA1901 Oct. 19	*Perkins, J.	Engineering Assistant, Council House, Birmingham.
1902 Mar. 22	Phillips, G. A.	Deputy County Surveyor, Glamorgan. Town Hall, Bridgend.
1902 Mar. 22	Ransom, W.	Chief Assistant Surveyor, Worcester. Midhurst, Bath Road, Worcester.
G1897 June 19 TA1901 Dec. 7	*Redfern, J. L.	Deputy City Engineer, Carlisle.
1902 Nov. 8	Rowbottom, J.	Chief Assistant, Borough Surveyor's Office, Ashton-under-Lyne.
1903 Mar. 21	Ryman, F. R., A.M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Bury, Lancs.
1903 June 6	Sadler, F.	Deputy Surveyor, Council Offices, Acton.
1903 June 25	*Saunders, E. Y.	Assistant Borough Engineer, Lowestoft.
G1894 Oct. 20 TA1902 May 10	*Savage, E. B., A.M. Inst. C.E.	Engineering Assistant, Council House, Birmingham.
1902 Nov. 8	*Shackleton, W., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Hanley.
G1899 Dec. 16 TA1901 Oct. 19	*Slater, F. J.	Assistant Surveyor, Town Hall, Camberwell, S.E.

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Date of Election and Transfer.			
G1899 Dec. 16 TA1901 Oct. 19	*Spreckley, J. A., A. M. Inst. C.E.		Deputy City Surveyor, Hereford.
1901 Dec. 7	Spurr, F. W.		Chief Assistant, City Engineer's Office, York.
G1895 Jan. 19 TA1901 Oct. 19	*Steele, W. J., A.M. Inst. C.E.		Deputy City Engineer, Bristol.
1903 Mar. 21	Sutcliffe, H.		Deputy Borough Engineer, Town Hall, Huddersfield.
G1898 Dec. 17 TA1902 Jan. 25	*Taylor, J.		Tramways Engineer, Town Hall, Bradford.
G1900 Dec. 15 TA1903 May 16	*Taylor, P.		Chief Engineering Assistant, Council Offices, Ilford.
1903 July 25	*Watmore Jas.		Assistant Surveyor, Council Offices, Aldershot.
G1899 June 10 TA1902 Mar. 22	*Weir, J. S.		Chief Assistant, Borough Surveyor's Office, Halifax.
1903 May 16	White, W. H. J., A. M. Inst. C.E.		Deputy Borough Engineer, Town Hall, Cheltenham.
1902 Mar. 22	Williams, H. B.		Chief Assistant, Borough Engineer's Office, Workington.
1902 July 10	Williams, J.		Assistant Borough Surveyor, Town Hall, Hampstead, N.W.
G1898 June 30 TA1901 Dec. 7	*Willis, E., Assoc. M. Inst. C.E.		Chief Engineering Assistant, Council Offices, Willesden, N.W.
1903 June 6	Wilson, A., A. M. Inst. C.E.		Sanitary Commissioner's Office, Gibraltar.
G1898 June 30 TA1901 Dec. 7	*Wilson, F.		District Surveyor, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19	*Yarwood, H.		Assistant Borough Surveyor, Town Hall, Rochdale.
G1901 June 8 TA1902 Feb. 22	*Yelland, T.		Deputy Borough Engineer, Town Hall, Leigh, Lancs.

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GRADUATES.

All Graduates hold the Certificate of the Association.

Date of Election.		
1893 Oct. 2	BALL, J. B., A.M. Inst. C.E.	Engineer's Office, L.D. & E.C. Railway, Chesterfield.
1901 Aug. 24	BARKER, H. W.	Surveyor to the Urban District Council, Walmer.
1903 Jan. 17	BATE, E. M.	Council Offices, Frinton-on-Sea.
1890 Mar. 29	BAYLEY, G. H., A.M.Inst.C.E.	17 Cooper Street, Manchester.
1897 July 31	BEARD, E. T., A.M. Inst. C.E.	4 The Crescent, Scarborough.
1898 Dec. 17	BELL, B.	City Surveyor's Office, Carlisle.
1902 Mar. 22	BERRINGTON, E. E. W.	28 Victoria Street, Westminster, S.W.
1900 June 16	BLAKEWAY-PHILLIPS, R. ..	City Engineer's Office, Westminster, S.W.
1901 Aug. 24	BLANCHARD, R.	Town Hall, Leicester.
1889 June 8	BLIZARD, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
1899 June 10	BRADSHAW, A. S.	Borough Engineer's Office, Bedford.
1892 Oct. 15	BRADSHAW, J. B., A.M. Inst. C.E.	R.E. Office, Rupert Lane Barracks, Liverpool.
1896 June 25	BRUCE, W.	Borough Engineer's Office, Edinburgh.
1889 July 4	BRYANS, J. G.	Sectional Engineer, Palermo Station, F.C.P., Buenos Ayres.
1899 June 29	BURGESS, R. W.	Town Hall, Stratford, E.
1903 June 6	BUTLER, H. L.	2 Glenmore Villas, Queen's Road, Farnborough.
1902 July 10	BUTTON, F. E.	City Surveyor's Office, Manchester.
1902 Feb. 22	CAMM, E.	Town Hall, Leicester.
1897 June 19	CARTLEDGE, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
1902 June 7	CHAMBERS, H. A.	Borough Engineer's Office, West Hartlepool.
1894 Oct. 20	CHASEMORE, A. E.	98 High Street, Putney, S.W.
1894 July 7	CLAYPOOLE, A. H., A. M. Inst. C.E.	City Engineer's Office, Bristol.
1894 July 7	CLEGG, H., A.M. Inst. C.E. ..	Borough Surveyor's Office, Oldham.
1897 June 19	CRESWELL, W. T.	11 Victoria Street, S.W.
1892 July 11	CROSS, F. W., A.M. Inst. C.E.	45 Bradford Street, Walsall.
1903 June 6	CUBITT, H. W.	County Hall, Spring Gardens, S.W.
1898 June 30	CUDBIRD, T. O.	City Engineer's Office, Guildhall, Norwich.
1901 June 8	DAVIDGE, W. R.	London County Council Offices, 19 Charing Cross Road, W.C.
1902 July 10	DAWKINS, F.	Borough Surveyor's Office, Bournemouth.
1902 July 10	DEELEY, G. P.	Monshall, Amblecote, Brierley Hill, Staffs.
1898 June 30	DENT, J. P.	1 Woodside Terrace, Nelson, Lancashire.
1903 June 25	DOUGLAS, S.	Council Offices, Wealdstone.

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Date of Election.		
1903 Oct. 17	Duncan, L. G.	79 Avenue Road, Southampton.
1899 June 29	Dyer, R. H.	Borough Engineer's Office, Southampton.
1898 Dec. 17	Essex, E. H.	Town Hall, Leyton, N.E.
1886 Sept. 11	Fenton, W. C.	14 St. James' Row, Sheffield.
1891 June 25	Finch, A. R., A.M. Inst. C.E.	Town Hall, Kensington, W.
1898 June 30	Finch, E. E.	Borough Surveyor, Town Hall, Bethnal Green, S.E.
1900 June 16	Fisher, R.	37 Inman Road, Harlesden, N.W.
1903 July 25	Ford, J.	43 Victoria Terrace, Barnsley.
1903 Feb. 21	Foster, J. W.	Town Hall, Bradford.
1903 June 6	Foster, W. A.	Park View, Manchester Road Accrington.
1896 Jan. 18	Fox, Senior L.	Town Hall, Newport.
1903 June 25	Gettings, S. S.	Town Hall, West Bromwich.
1899 June 10	Gibson, W. S.	"D'Arcyville," Victoria Road Hendon.
1888 July 12	Glass, S. N., A.M. Inst. C.E.	16 Ravenscroft Road, Chiswick.
1898 Jan. 15	Grimley, F. C.	The Depôt, Harwich.
1901 June 27	Harlow, W. W. R.	Council Offices, High Street, Grays.
1901 June 8	Harris, K. J. S.	St. George's Hall, Mount Street, London, W.
1900 May 19	Harrison, J. W.	106 Raffles Road, Tranmere, Birkenhead.
1903 June 25	Harrison, P. T.	Town Hall, Hove, Sussex.
1903 Jan. 17	Heath, J. R.	Town Hall, Burslem.
1893 Jan. 14	Hellawell, O.	Town Hall, Withington, Manchester.
1903 Oct. 17	Hill, H. F.	Town Hall, Ilford.
1896 June 25	Hills, O. C.	360 Mare Street, Hackney, N.E.
1900 June 16	Hobson, E.	6 Keyworth Road, Hillsborough, Sheffield.
1888 July 12	Houghton, J.	King's Heath, Birmingham.
1903 Jan. 17	Howells, D. P.	16 Ropewalk, Neath, S. Wales.
1901 Aug. 24	Hull, G. E.	Municipal Offices, Benares, India.
1899 June 10	Hutchings, W. A.	Town Hall, Islington, N.
1901 May 11	Johnston, C.	P.W.D., Begari Canals, Jacobabad, Camp Khairo, Garki, Sindh, India.
1903 May 16	Jones, F. W.	Public Offices, Frome.
1901 June 8	Jones, H. O.	Borough Engineer's Office, Folkestone.
1903 July 25	Jones, T.	53 Princes Street, Southport.
1895 Oct. 19	Julian, J.	Borough Surveyor's Office, Cambridge.
1896 June 25	Kieser, W. H. G.	City Engineer's Office, Bristol.
1893 June 24	Killick, W. H.	Borough Surveyor's Office, Southampton.
1896 June 25	Kirk, J. W.	Town Hall, Westminster, S.W.
1903 June 25	Knight, R. R.	1 Barratt Avenue, Wood Green, N.
1903 June 25	Knowles, G. P.	L.C.C., 19 Charing Cross Road, W.C.
1903 June 25	Lees, H. B.	Town Hall, Birkenhead.
1903 June 25	Mann, E. E.	13 Algernon Road, Brondesbury Road, Kilburn, N.W.
1903 Jan. 17	Marrian, H. G.	Rylstone, Park Road, Hale, Altrincham.

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Date of Election.		
1900 Dec. 15	MacDonald, K. G.	13 Charles Street, St. James's, S.W.
1894 Jan. 13	Martin, E. B., A.M.Inst.C.E.	City Engineer's Office, Leeds.
1900 June 16	Mattinson, H.	55 Piccadilly, Manchester.
1903 Jan. 17	Masters, W. H.	Glencairn, Arthur Road, Southampton.
1898 Dec. 17	May, C. G.	P.W.D., Malacca, Straits Settlements.
1901 Oct. 19	Milnes, B.	Town Hall, Birkenhead.
1899 June 10	Moss, P. A.	121 Highbury Hill, Highbury, N.
1902 Jan. 25	Moss, W.	30 Hale Lane, Failsworth, Manchester.
1903 Oct. 17	Nash, F. O. C.	Town Hall, Rochdale.
1902 July 10	Nathanielsz, A. H.	Water Engineer's Office, 45 John Street, Glasgow.
1896 June 25	Nightingale, C. F.	6 Westbourne Road, Walsall.
1901 Aug. 24	Oxberry, F. W.	32 East Mount Road, York.
1899 Oct. 21	Palmer, G. F.	New Dock, H.M. Dockyard, Chatham.
1901 Feb. 6	Palmer, W. L. F...	City Engineer's Office, Bristol.
1902 Mar. 22	Parr, J. E.	Council House, Handsworth, Staffs.
1896 Feb. 22	Perkins, T. L., A.M. Inst.C.E.	4 Linzee Road, Hornsey, N.
1903 Feb. 21	Perrott, E. S.	6 Elliston Road, Redland, Bristol.
1902 July 10	Phillips, R.	14 Churchill Road, Willesden Green, N.W.
1901 Aug. 24	Pickin, W. H.	Sewerage Works, Rickmansworth.
1899 Oct. 21	Plant, W.	Borough Engineer's Office, Leicester.
1888 Sept. 15	Pritchard, T., A.M.Inst.C.E.	264 Gresham House, Old Broad Street, E.C.
1898 June 30	Quick, A. H..	15 Fernholme Road, Newlands, S.E.
1903 June 25	Rattenbury, O. B.	7 Crofton Villas, Canterbury Street, New Brompton, Kent.
1900 Dec. 15	Rawstron, C. O.	29B High Street, Rotherham.
1901 June 8	Read, F...	Town Hall, Leyton, N.E.
1902 Nov. 8	Redford, W. T.	Town Hall, Eccles, Lancs.
1899 Mar. 25	Richards, E. P.	Borough Engineer's Office, Southend-on-Sea.
1901 Aug. 24	Riley, J.	Drainage Engineer's Office, Cape Town, S.A.
1899 June 29	Rose, J. G.	Great Knollys Street, Reading.
1903 June 6	Roseveare, L.	Borough Engineer's Office, Plymouth.
1900 Feb. 10	Ross, D.	Brede, Sussex.
1901 Feb. 16	Rothera, A.	Borough Engineer's Office, Salford.
1900 June 16	Rousell, A. J.	Borough Engineer's Office, Worthing, Sussex.
1902 July 10	Shepherd, G. G.	Town Hall, Ilford.
1899 June 29	Simms, F.	Town Hall, Sheffield.
1898 Jan. 15	Smith, G. H.	1 Worcester Road, Wimbledon, S.W.
1898 June 30	Spink, J.	City Surveyor's Office, Manchester.

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Date of Election.		
1899 June 29	STANTON, F. W. S., A.M. Inst. C.E.	c/o Messrs. J. Mansergh & Sons, 5 Victoria Street, S.W.
1903 June 25	STEVENS, H. L.	14 High Street, Watford.
1898 June 30	SUTTON, W. F.	Water Department, Broad Street Birmingham.
1902 Feb. 22	TAIT, W. I.	Council Offices, Nuneaton.
1900 Dec. 15	TAYLOR, H. T.	11 Newton Road, Hoylake, Cheshire.
1902 July 10	TAYLOR, S.	Town Hall, Manchester.
1899 June 10	THACKERAY, J. R.	Borough Engineer's Office, Eastbourne.
1902 Jan. 25	THOMAS, W. G.	Daylesford, Mountain Ash.
1898 June 30	TIFFIN, T. E., A.M.Inst.C.E.	Surveyor to the Urban District Council, Dartford.
1900 June 16	TREMELLING, H.	Borough Engineer's Office, Newport, Mon.
1903 Jan. 17	TRESEDER, F. H.	The Nurseries, Cardiff.
1902 July 10	TOMLINSON, J. W., A.M. Inst. C.E.	St. Mary's Hall, Coventry.
1900 Oct. 13	TOMPKINS, H...	6 Ethel Street, Wells, Somerset.
1900 June 16	TOWNER, H. V.	P.W.D., Malacca, Straits Settlements.
1902 Nov. 8	WALKER, A. H.	128 Prince of Wales Road, London, N.W.
1900 Dec. 15	WALKER, H.	Surveyor, Urban District Council, Council Offices, Wealdstone.
1888 Jan. 14	WARD, F. D., A. M. Inst. C.E.	38 High Street, Welshpool.
1900 May 19	WARLOW, W. R.	Nolton House, Windmill Road, Brentford.
1898 Jan. 15	WARREN, A. R.	Surveyor to the Urban District Council, Milton-next-Sittingbourne.
1897 June 19	WEBB, F.	Town Hall, Chelsea.
1898 Jan. 15	WELLS, F. B.	c/o The Great Southern Railway Co., Buenos Aires, South America.
1902 Sept. 6	WEST, A. S.	Borough Engineer's Office, Harrogate.
1902 Jan. 25	WHITE, C. D...	Council Offices, Hanwell.
1901 June 8	WHITEFORD, E. H., A.M. Inst. C.E.	Engineer's Office, Derwent Valley Water Board, Bamford, near Sheffield.
1902 July 10	WHITAKER, G. H.	Town Hall, Sunderland.
1902 Nov. 8	WIBBERLEY, J.	Assistant Borough Surveyor, Municipal Offices, Guildford.
1901 June 27	WILLETT, A. J.	18 Castledine Road, Anerley, S.E.
1902 July 10	WILKINSON, F.	Town Hall, Rochdale.
1901 Aug. 24	WILKINSON, H. F.	Fulford House, The Crescent, South Tottenham, N.
1895 June 27	WILLIAMS, D. S.	Hopes Green Road, South Benfleet, Essex.
1901 Dec. 7	WILLIAMS, J. H.	Town Hall, Burnley.
1902 Sept. 6	WILLIAMS, W. W.	14 Countess Street, Stockport.
1900 Dec. 15	WILLS, A. J.	Harrisburg, Pennsylvania, U.S.A.
1901 Aug. 19	WILSON, H. B.	Town Hall, Wood Green, N.
1900 July 19	WRACK, W. P.	117 High Street, Poplar, E.

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PARLIAMENTARY AND GENERAL PURPOSES COMMITTEE.

J. P. BARBER (ISLINGTON), *Chairman.*

W. N. BLAIR (St. Pancras).
J. W. COCKRILL (Great Yarmouth).
A. D. GREATOREX (West Bromwich).
W. HARPUR (Cardiff).
CHAS. JONES (Ealing).
E. G. MAWBEY (Leicester).
J. PRICE (Birmingham).
O. C. ROBSON (Willesden).
H. T. WAKELAM (Westminster).
W. WEAVER (Kensington).
T. H. YABBICOM (Bristol).

FINANCE COMMITTEE.

W. WEAVER (KENSINGTON), *Chairman.*

J. P. BARBER (Islington).
J. A. BRODIE (Liverpool).
A. E. COLLINS (Norwich).
C. H. COOPER (Wimbledon).
W. HARPUR (Cardiff).
CHAS. JONES (Ealing).
J. S. PICKERING (Nuneaton).
J. PRICE (Birmingham).
C. F. WIKE (Sheffield).
T. H. YABBICOM (Bristol).

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THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

THIRTIETH ANNUAL MEETING.

KENSINGTON, *June* 25, 26 *and* 27, 1903.

THE Members assembled in the Town Hall, Kensington, the use of which had been kindly granted by the Mayor and Corporation.

The Mayor (Major Lewis H. Isaacs, J.P.) offered the Association a very hearty welcome to Kensington.

The President, Mr. T. H. Yabbicom, on behalf of the Association, returned thanks for the kind welcome offered them.

The Secretary then read the Minutes of the last Annual General Meeting, which were confirmed and signed.

The Secretary read the Council's Annual Report.

ANNUAL REPORT.

The Council have pleasure in presenting their Annual Report.

DISTRICT MEETINGS.

Since the last Annual General Meeting 7 District Meetings have been held: At Shipley, September 13, 1902; at West Bromwich, September 20; at Aldershot, October 11; at King's Lynn, October 18; at Birmingham, January 13, 1903; at London, March 27; and at Sudbury, June 13.

THE ROLL OF THE ASSOCIATION.

During the financial year ended April 30 last, 57 new Members, consisting of 22 Ordinary Members, 11 Associates and 24 Graduates, have joined the Association; 20 Members

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have resigned, 18 names have been written off, and the Council record with regret the deaths of Messrs. J. H. Burton, W. Fraser, J. Myatt and W. L. Walker.

The number on the roll of the Association at the close of the year was 8 Honorary Members, 810 Ordinary Members, 83 Associates and 133 Graduates, making a total of 1034.

Two Graduates have been transferred to the class of Members, 11 Graduates to the Associate class, and 4 Associates to the class of Members.

The Finances.

The Audited Balance-Sheet and Statement of Accounts which accompany this Report show a Balance in hand on April 30 last of 563*l.* 13*s.* 11*d.* A considerable amount shows under liabilities, on account of there being no meeting of the Council in April, when these accounts would otherwise have been settled.

The satisfactory state of the finances reported in previous years is equally evident in the accounts herewith submitted, the financial position of the Association being sound and progressive.

The Examinations.

Four examinations have been held since the last report—one at Liverpool in October, 1902, when 24 candidates presented themselves for examination. Of these 12 satisfied the examiners, and were granted their certificates.

Three other examinations were held in London in April, 1903, when 18 candidates presented themselves on each occasion, making a total of 54 for the three examinations. Of these 32 satisfied the examiners and were granted their certificates.

The examiners were for the first of these examinations Messrs. Eayrs, Lemon, Lobley and Thomas; for the second examination Messrs. Eayrs, Fowler, Lemon and Lobley; for the third examination Messrs. Collins, Jones, May and Thomas; and for the fourth examination Messrs. Davis, Laws, Robson and Wakelam.

The Council have considered it advisable that proof of education and training should be given by candidates for these examinations, and have therefore arranged that henceforth they must supply the necessary information upon these points before

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being allowed to sit. The value of the Association's Certificate will, in the opinion of the Council, be much enhanced by these steps.

The increasing appreciation of these examinations is shown by their growth, a larger number of candidates having entered for them this year than for any previous year.

Premiums.

The Council have awarded premiums of 5*l.* each, to Mr. Alfred Fidler, for his paper on "The Municipal Work of Southend-on-Sea," read at the District Meeting held at Southend on September 28, 1901, and to Mr. J. S. Pickering, for his paper on "Municipal Work in Nuneaton," read at the District Meeting held at Nuneaton on October 19, 1901.

Secretary's Salary and Office Rent.

Upon an application of the Secretary for a reconsideration of his remuneration, the Council decided to alter the existing arrangements under which the salary paid to the Secretary included the use of his offices, and have accordingly, on behalf of the Association, become tenants of the offices at 11 Victoria-street, Westminster, renting them at 75*l.* per annum.

The salary of the Secretary was at the same time fixed at 275*l.* per annum, with an allowance for an assistant of 78*l.* per annum.

Re-Elections.

In carrying out the provisions of by-law 5*a*, your Council have in each case of re-election endeavoured to secure all the information possible where a Member gives up his public position, and require to be quite satisfied in these matters before reinstating the applicant in the List of Members.

The New Council.

The ballot-lists having been duly issued, the scrutineers reported the result of the voting as follows:—

President.—Mr. William Weaver.

Vice-Presidents.—Messrs. J. Patten Barber, A. E. Collins and A. T. Davis.

Ordinary Members of Council.—Messrs. W. N. Blair,

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J. W. Bradley, J. A. Brodie, C. H. Cooper, A. Creer, A. D. Greatorex, E. P. Hooley, E. J. Lovegrove, F. J. C. May, J. Paton, J. S. Pickering, S. S. Platt, J. Price, H. T. Wakelam, and C. F. Wike.

Hon. Treasurer.—Mr. Lewis Angell.

Hon. Secretary.—Mr. Chas. Jones.

Elective Past-President.

In accordance with the Articles of the Association the Council have elected Mr. W. Harpur, Past-President, *vice* Mr. J. T. Eayrs retiring under Article 26.

"Model" By-Laws.

The operation of the "model" by-laws issued by the Local Government Board for new streets, etc., as well as for those for use by rural authorities, is being considered by a committee of your Council. Efforts are being made to obtain the views of the Local Government Board, and at the same time the assistance of the Association will be duly offered in any further issue that may be made by the Board.

Engineering Standards Committee.

The Council have received a lengthy Report from their delegates who are representing this Association on the Committee, setting forth the work of the Sub-committee on Tram Rails.

The Committee have adopted the report of the Sub-committee, in so far as it refers to tram-rail sections, the question of specifications for their manufacture being left open for future consideration. The report states that "after much correspondence and several meetings, five sections of tramway rails were agreed upon—viz., for weights of 90 lb., 95 lb., 100 lb., 105 lb. and 110 lb." and it is noted that the Board of Trade have approved these proposed sections.

With regard to a standard specification, considerable difficulties have been met with, and it was finally decided to refer the matter back to the sub-committee and they might consider the question of having one analysis for both acid and basic steel.

The Council desire to tender their best thanks to Messrs.

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Harpur and Wike, who have undertaken to represent the Association upon the committee, as the obviously large amount of work must necessarily entail a considerable sacrifice of time and personal expense.

Highways Administration: Local Government Board.

Your Council addressed the Local Government Board's Highway Department, with a view of setting forth the fact that this Association was peculiarly fitted to tender evidence before the inquiry, which it is understood is to be held by the department, and respectfully offering to tender evidence thereat.

The Board, however, decline to accept the assistance so offered, giving as their reason the fact that other associations have been decided upon, and, in the view of the Board, are sufficient. The Council have, however, pointed out to the department that the evidence of those associations—viz., the County Council's Association, and the Association of Municipal Corporations—although doubtless of the highest possible value of its kind, could not be of that engineering value which must be so desirable, and which evidence tendered by this association must undoubtedly possess.

Sanitary Inspectors and the Local Government Board.

The published statement of the Sanitary Inspectors' Association with regard to a suggested alteration in the duties of the sanitary inspectors having been brought under notice, your Council directed a communication to the Local Government Board, as well as to the London County Council, to counteract as far as possible the effect of the statement made by the Sanitary Inspectors' Association, and asking that no change should take place in the respective duties assigned to the two distinct departments to which the sanitary inspector on the one hand, and the municipal engineer on the other, belong.

Scottish District.

The Council, with the kind co-operation of Mr. Dyack, have succeeded in arranging for a meeting to be held at Aberdeen on

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August 20, 21, and 22, 1903, which promises to be of great interest.

The opportunity will be taken to elect a gentleman to take up the duties of Hon. Secretary for Scotland. Every endeavour will be made to bring the advantages of the Association within reach of those holding office as engineers and surveyors to the authorities in Scotland.

The Council would urge upon the Members generally the desirability of making a strong effort to attend this meeting, and so to assist in the inauguration of what it is hoped will prove a strong and flourishing district of the Association.

Conclusion.

In conclusion, your Council, while congratulating the Members upon the highly satisfactory position the Association now holds, would impress upon them the necessity for the most earnest co-operation, and more especially in the direction of attendance at the several district meetings held throughout the country.

Charles Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

On the motion of the President, seconded by Mr. A. T. Davis, the Report was received and adopted.

The President presented the Premiums awarded for the best papers contributed by Members during the past year, and contained in the last volume of Proceedings. The first—5*l.* in books—to Mr. A. Fidler, for his paper on "Municipal Work at Southend"; and the second—of equal value—to Mr. J. S. Pickering, for his paper on "Municipal Work at Nuneaton."

It was moved, seconded and carried, that Mr. Richardson, of Handsworth, be elected Honorary District Secretary of the Midland District, and Mr. Pickering, of Cheltenham, be elected Honorary District Secretary for the Western District, and that the other District Secretaries continue in office till the next Meeting in their respective districts.

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Mr. MacBrair and Mr. Stallard were appointed Auditors for the ensuing year.

Messrs. F. J. Harris, H. Shaw and F. S. Yates were appointed Scrutineers for the ensuing year.

Mr. Yabbicom then introduced his successor, Mr. William Weaver, and vacated the chair in his favour.

Mr. J. P. Barber proposed a hearty vote of thanks to the retiring President for his services to the Association during the past year. He had carried out the difficult and responsible duties of President in a manner which was quite worthy of the office he had held. This was seconded by Mr. Chas. Jones and carried with acclamation.

Mr. Yabbicom acknowledged the vote.

Mr. Weaver then read his Inaugural Address,* a hearty vote of thanks for which was proposed by Mr. J. T. Eayrs, seconded by Mr. C. H. Cooper, and carried unanimously.

The following papers were read and discussed:—

"Experimental Bacterial Treatment at the L.C.C. Outfalls," by F. Clowes, D.Sc. "Sewage Treatment," by W. D. Scott-Moncrieff. "Trees in Public Roads," by F. Smythe. "Motor Vans for Municipal Purposes," by T. W. E. Higgens. "Minimising the Risk of Fire in Temporary Buildings," by T. W. Aldwinkle. "Cremation," by W. N. Blair.

Votes of thanks to the several Authors of the Papers, and to the Mayor and Corporation of Kensington for the use of the rooms in the Town Hall for the purposes of the Meeting, were passed unanimously.

* This Address and the Papers read at the Meeting will be found at the end of the Volume.

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Dr. STATEMENT OF RECEIPTS AND EXPENDITURE

RECEIPTS.	£	s.	d.
To Balance, May 1, 1902	477	1	5
„ Entrance Fees of Members and Associates	32	11	0
„ Subscriptions	872	8	0
„ New Graduates	12	1	6
„ Subscriptions in advance	16	19	0
„ Arrears	143	17	0
„ Sale of 'Proceedings'	30	6	6
„ Examination Fees	294	10	6
„ Interest on Investments	39	17	8
„ Sale of Glasgow Congress Volume	0	6	6
„ Balance of Petty Cash due to Secretary	4	18	0
£	1924	17	1

STATEMENT OF ASSETS

LIABILITIES.	£	s.	d.	£	s.	d.
To Estimated Liability on Vol XXIX.				40	0	0
„ Examination Expenses				20	0	0
„ Sundry Printing				9	10	0
„ Messrs. Clowes for Vol. XXVIII.—						
For Printing Volume	266	16	6			
Postages	53	9	7			
Sundry Printing	74	14	5			
				395	0	6
„ Reporting				8	8	0
„ Secretary, Petty Cash				4	18	0
„ „ for Assistant				7	10	0
„ Sundry Creditors				5	0	0
„ Rent of Office, etc., One Quarter to March 25				20	2	0
„ Balance				1571	9	7
£				2081	18	1

Examined with the vouchers and

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FOR THE YEAR ENDING APRIL 30, 1903. Cr.

EXPENDITURE.	£ s. d.	£ s. d.
By Reports of Meetings	..	42 0 0
„ Examiners' Fees and Expenses	..	162 4 7
„ Messrs. Clowes, for Vol. XXVII. and Glasgow Congress Volume, and sundry printing	..	496 13 2
„ Scrutineers' Expenses	..	2 13 6
„ Meetings, Expenses	..	28 5 7
„ Printing and Stationery	..	61 1 2
„ Messrs. Sprague, Illustrations	..	88 0 6
„ Rent of Telephone	..	7 7 8
„ Secretary, Salary and Rent	..	293 15 0
„ Allowance for Assistant	..	56 10 0
„ Travelling Expenses	..	31 7 1
„ Bankers' Charges	..	2 3 11
„ Premium	..	10 0 0
„ Law Charges	..	6 6 0
„ Return of Examination Fees	..	16 16 0
„ Return of Subscription	..	1 1 0
„ Petty Cash—		
Postages	35 13 7	
General	19 4 5	
		54 18 0
„ Balance	..	563 13 11
	£	1924 17 1

AND LIABILITIES.

ASSETS.	£ s. d.	£ s. d.
By Balance at Bank, May 1, 1903	..	563 13 11
„ £490 Southampton Corporation Stock at 96	..	470 8 0
„ £553 12s. 9d. India 2½ % Stock at 84	..	465 0 0
„ £261 14s. 7d. London County Council 2½ % Consols at 85	..	222 9 0
„ £200 Metropolitan 2½ % Consolidated Stock at 86 ..	..	172 0 0
„ Loan to Joint Exam. Board San. Insp.	..	15 0 0
„ Subscriptions in Arrear	116 18 6	
Less 50 % bad	58 9 3	
		58 9 3
„ 'Proceedings' in Stock	339 11 8	
Less 75 %	254 18 9	
		84 17 11
„ Office Furniture	..	30 0 0
	£	2081 18 1

found correct, *May* 22, 1903.

SIDNEY STALLARD
R. A. MACBRAIR } *Auditors.*

LEWIS ANGELL, *Treasurer.*
CHARLES JONES, *Hon. Secretary.*
THOMAS COLE, *Secretary.*

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YORKSHIRE DISTRICT MEETING AT SHIPLEY.

September 13, 1902.

Held in the Council Chamber, Shipley.

T. H. YABBICOM, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Members were received and cordially welcomed by the Chairman of the Council (Mr. C. B. Shaw, J.P.).

The President, on behalf of the Association, thanked the Chairman and Members of the Shipley Urban District Council for their kindness in inviting the Association to Shipley, and pointed out that the visits paid by the Association were mutually advantageous to the Members and to the town visited.

The Minutes of the last Yorkshire District Meeting were taken as read.

Mr. W. H. Hopkinson (Keighley) was unanimously re-elected as the Honorary District Secretary.

The following paper was then read and discussed.

MUNICIPAL WORKS AT SHIPLEY.

BY I. LINDOW, CLERK OF THE COUNCIL AT SHIPLEY.

IN presenting this paper the Author desires to state that he is indebted for much of the information contained herein, to the various engineers, surveyors and architects, under whose charge the works described were carried out.

Lord Iddesleigh, in his Presidential Address at the recent Health Congress at Exeter, expressed the opinion that the two

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most important matters with which sanitary authorities have to deal, were water supply and sewage disposal. Judged not only from this standard, but several other characteristics of sound local government, it may be predicted that even under such a critical eye as that of the Association of Municipal and County Engineers, the Shipley district will be found to have kept pace with the march of progress. The town has been practically remodelled, but the heavy expenditure which has been incurred on street improvement works has abundantly justified itself, in that it has without doubt materially contributed to the progress of the district. It may fairly be claimed that the town is now generally provided with good wide sanitary streets, and that "slum" property, in the sense generally understood by that expression, is practically non-existent. Public needs and requirements have been provided for by an efficient scheme of waterworks, a thorough system of drainage with outfall and purification works, public cemetery of 20 acres, isolation hospital, parks, modern public abattoirs, fire brigade, fever and accident ambulance stations, and public mortuaries, whilst the District Council have recently added, as part of the municipal works, the acquirement of the gasworks, the municipalisation of the Salt schools, and the institution of an electrical supply station for traction, lighting and motor-power purposes. These works have been and are being carried out, under three Acts of Parliament and seventy-five Provisional Orders, and sanctions for loans amounting in the aggregate to 751,281*l.* The growth of the district is shown by the following figures: the population, which in 1881 was 15,089, is now over 26,000, whilst the rateable value in the same period has advanced from 68,000*l.* to over 108,000*l.*

WATERWORKS.

In the year 1853 Shipley was constituted a local government district under the Public Health Act, 1848, and in the following year the Authority obtained the Shipley Waterworks Act, empowering them to construct waterworks, and thus giving them the right to supply what has now become a very large consumption of water. The population of Shipley at that time was under 5000; it is now 26,000, so that, obviously, very considerable extensions of waterworks have had to be made. Further

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powers were obtained in an Act of 1874, and the storage reservoirs were increased to the extent of 95,000,000 gallons, so that at present, with a storage capacity of nearly 140,000,000 gallons, Shipley is provided with a storage equal (apart from compensation water) to 120 days' supply. The gathering grounds, which comprise an area of over 2000 acres, form part of the far-famed Rombalds Moor. Shipley people are extravagant users of water, the consumption per head of the population being 25 gallons per day. In regard to water consumption, the position of Shipley is somewhat singular, for whereas the receipts from water used for domestic purposes have increased over 20 per cent. during the past seven years, the income from trade consumption has actually decreased. In an industrial centre such as Shipley, this is no doubt exceptional: but it is due to the circumstance that manufacturers have availed themselves of the facilities for obtaining water from the canal and the river, and also by means of wells, the valley in which Shipley is situated providing a good supply of water for dyeing and other trade purposes. Some towns, with no larger population than Shipley, have five times the income from water used for trade purposes; but for the same reason that accounts for the comparatively small revenue from this source, the district is probably a gainer in that it becomes more attractive for industrial concerns. The meagre consumption for trade purposes also lessens the difficulty of meeting the ever-growing demand for domestic and sanitary use. The want of elasticity in the income from water prevents the rates being benefited from that source, but the Council are enabled to encourage the use of water for sanitary purposes. In another sense the Shipley consumers have a right to congratulate themselves, because, whereas in most towns there is an extra charge made for baths and water-closets, householders in Shipley are entitled to one bath and one water-closet free, no extra charge being made for these on the ordinary scale charge for domestic purposes. The saving to a householder in a house assessed, say at 15*l.*, is equal to a rate of 8*d.* in the £. It may be argued with some show of reason that free baths and water-closets are unfair to those consumers who have no such privileges, and who have, therefore, to accept the burden of providing for their more fortunate neighbours. An important consideration, however, is the encouragement which it gives builders to make

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healthy sanitary provision, and new houses without baths and water-closets are now the exception. The expenditure on water-works account has been 125,000*l.*

SANITATION.

Shipley is provided with a thorough system of drainage, both in regard to street drains and main outfall sewers, though the complete interception has not yet been carried out. Good sanitation is difficult, if not impossible, of attainment, without proper provision in the way of street sewers, and in this way the policy adopted by the Shipley sanitary authority in its early days has borne good fruit, as the needs of the community increased. The early adoption of an expensive street improvement scheme got rid of a considerable area of old property, paved the way for the provision of wide streets, both at the back and front of dwelling-houses, and led to the adoption of stringent bye-laws, striking testimony to the benefit of which is afforded by the wide, healthy thoroughfares to be found in the district. During the past ten years there have been over 1000 houses erected in the district, of which not more than a score have been provided with the common privies. Whilst insisting on thorough drainage to the houses, the Council have also had before them the necessity of the gradual removal of the common privies, and the substitution therefor of waste-water closets or the ordinary water closets flushed from the town's mains. Within the last five years about 1000 common privies have been converted into water-closets, the most notable instance of this conversion in the district being the "model village" of Saltaire, which was built over forty years ago on what was then considered an admirable principle. But the streets were narrow, and the old privies a constant nuisance and danger to health. To the credit of the Saltaire firm (Sir Titus Salt, Bart., Sons & Co., Ltd.), they resolved to carry out a privy conversion scheme for the whole of their 800 houses. This scheme entailed a very heavy cost, but the benefit is to be seen in the improved health of the community, and the sweeter surroundings of the dwellings. The example set by this firm is being followed pretty generally, and the authority have not met with much disinclination on the part of owners to get rid of the old insanitary conditions. This improvement has also enabled the Council to deal more effectively with another department, that of ashpit cleansing.

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As the old system disappears, ashpit refuse becomes more valuable at the destructor for steam-producing purposes. The ashpit cleansing is thoroughly carried out by the Council's own workpeople, the letting of the work by contract having been discontinued in the present year, the Council providing both manual and team labour. Power to provide public slaughter-houses was obtained in the year 1874, but it was not until 1890 that the abattoir was opened and private slaughter-houses closed. It is a fact worthy of mention that the whole of the private slaughtering places in the district were closed without the authority having to pay a single penny compensation. The butchers themselves recognised the importance of a central establishment, and acquiesced in the action of the Council without much demur. The Windhill district, which was added to Shipley in 1891, was brought under the provisions of the Act in 1895, and there also all private slaughter-houses were closed. Although not large, the new abattoir is fitted up with the most modern appliances. The abattoir has not only secured the removal of insanitary private places, but also ensures a regular and systematic inspection of meat by an officer of the town. The difficulty of getting rid of the offal was one which the Council only overcame when they were able to have it destroyed at the destructor. On capital account the outlay on the abattoir has been 4500*l.*, and the maintenance and sinking fund charges amount to about 100*l.* per annum more than the income, but the Council consider it money well spent, and this view is endorsed by the general body of ratepayers. Under the provisions of an Act passed last session, the Council obtained powers to make ice and provide storage for it in connection with their abattoir, but the Local Government Board objected to the Council having a clause enabling them to become traders in ice. The Council have not yet carried out a cold storage scheme, but the necessity for such provision has been frequently urged upon them by the butchers, and it is expected that a move will be made in the matter before long.

Cemetery.

The cemetery may be regarded as another sanitary measure, and was, as a matter of fact, sanctioned under the sanitary clauses of the Public Health Acts. The cemetery grounds, nearly 20 acres in extent, are situate in a picturesque spot

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known as Nab Wood, at the western boundary of the township, and are in every respect most suitable for the purpose, the subsoil being a formation of Esker gravel of the driest and most porous kind. The provision of a cemetery was carried out in the years 1894 and 1895. The works comprised a lodge and office for the registrar, conservatories, chapel and the laying out of the grounds. A sum of nearly 12,000*l.* has been expended in this direction, and the income is steadily increasing, the receipts for the year ended March last showing a total of 617*l.* The cemetery has been laid out on plans prepared by Mr. W. H. Dawson, the Council's Surveyor.

Isolation Hospital.

The necessity of providing an isolation hospital, was forced upon the town by the closing of the Bradford Fever Hospital to the outside districts, and in 1890 the Council acquired 2 acres of ground at Stony Ridge, an elevated and healthy part of the district near to the western boundary. Exclusive of a grant of 736*l.* from the authorities of the Bradford Fever Hospital, the Council have expended 3921*l.* The buildings comprise administrative block, four wards, washhouses, disinfecting chambers, mortuary, laundry and smallpox hospital of two wards. The hospital was at first under the control of a joint hospital board, consisting of representatives from the Shipley and Windhill authorities, but when these two districts became amalgamated in 1891, the joint board was dissolved, and the hospital came under the control of the Shipley authority. The hospital has grown in popularity with the inhabitants, and whereas in the early days there was a disinclination on the part of the parents to send their children to the hospital, it is now a common statement of the medical officer, that the whole of the cases of fever notified to him have been sent there for treatment. This department of the Council's work is one of the most successful: there has not only been a decrease of epidemics, but an actual saving of life, deaths in the hospital having been very rare.

Parks.

The Council cannot show any very extensive provision in the way of parks and pleasure grounds, but no work carried out by the authority has been more appreciated than the conversion

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of an unsightly worked-out stone quarry (4 acres in extent) in the centre of the district into a tastefully laid out pleasure ground. The Council have recently, too, acquired a large recreation ground in the Windhill part of the district, which it is intended to suitably lay out. This is about $4\frac{3}{4}$ acres in extent, and the Council have power, under their Act of last year, to provide a refreshment pavilion, band-stand and music. In addition to these parks, which entail public expenditure, the inhabitants have also the advantage of an admirably situated and beautifully laid out park at Saltaire, the free public use of which is generously permitted by the Saltaire firm.

Tramways.

The Council have obtained power for an extensive provision of tramways for the district. The first purchase of tramways by the Shipley Council took place in 1894, when they acquired the lines which had previously been used for horse trams by a company which failed to make them pay. This line, known as the Bradford and Keighley Road Tramway, was afterwards leased to a tramway company at a rental, but in the present year the Council arranged for the conversion of the line for electric traction. In May the conversion was completed to double line for a distance of about $1\frac{1}{2}$ miles. In the meantime the Council had installed their electricity works, and they were able to add to their supply of current lighting and power, that of tramway traction. The Council were not called upon to decide the question as to what system of haulage—overhead equipment, surface contact or conduit—should be adopted, this point being settled by an agreement come to in 1897 with the Bradford Corporation, whereby this particular line had to be leased to the Bradford authority and converted to the same system of haulage which they adopted for the city tramways. As this was the overhead trolley system, the Shipley Council followed suit with their line.

The Tramway works in the Bradford and Keighley Road have been carried out on the plans of Mr. R. C. Quin, M.I.E.E., Consulting Engineer, who has directed the contracts except those for the permanent way, which have been superintended by Mr. Dawson, the Council's Surveyor.

The tramway is constructed with girder rails weighing 91 lbs. to the yard, fastened with girder joints and fishplates

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with helicoid lock-nuts to the bolts, the bed of the rails and granite setts being 6 inches solid concrete.

In the construction of the permanent way the engineer has taken the view that the life of a tramway rail is the life of the joint, and given extra strength to this part of the work to prevent excessive wear.

With regard to the overhead line, this is constructed of 000 S.W.G. hard-drawn copper, supported on insulators made under Quin's patent. This insulator, while having the merit of being slightly cheaper than the older form, has also the advantage that it will stand considerably higher electrical pressures than any other type, and that it is also mechanically stronger.

The line throughout is protected by Quin's patent automatic cut-outs, for prevention of trolley wire accidents arising from falling telegraph or telephone wires and broken trolley wire.

The current is supplied from the Council's central station at Dockfield, from whence the feeder cables are laid a distance of about a mile.

These cables will, however, serve for the future lines, which will take the current at points much nearer the Electricity Works.

Sewerage and Sewage Disposal.

The sewerage and sewage disposal works have been carried out under two engineers—Mr. M. Paterson, C.E., for the Shipley portion of the district, the main intercepting sewers and sewage works; and Messrs. W. B. Woodhead and Son, Civil Engineers, for the sewerage of the Windhill district. Plans were adopted in 1894; and early in 1897 the sanction of the Local Government Board was obtained to an expenditure of 56,000*l*. Since that time the Council have been continually spending money on sewerage and outfall works, with the result that the original estimate has been exceeded by 30,000*l*., and a further sanction beyond that is expected to be necessary. The Shipley main intercepting sewers extend along the whole valley lines of the district, comprising the whole of the old sewerage system in its course, and embracing a total length of over 4½ miles of sewers, varying from 9-inch pipes to 4½ feet by 3 feet brick and concrete culverts. The main outfall commences above the *Hospital* at an elevation of 686 feet O.D. and terminates at

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Dockfield Pumping Station at a level of 195 feet O.D. after a course of 3¼ miles. In this course there are three tunnels—one under the Midland Railway, another under Saltaire Mills Yard, and a third under Dockfield Mill. There are also two canal crossings and a syphon across the Bradford Beck. The Valley Road outfall extends from the Bradford boundary at a level of 245 feet O.D. and extends over a course of 1 mile, which involves one tunnel at Pricking Bridge and two crossings of the Bradford Beck. The Windhill sewage discharges at two points into the Valley Road sewer, which is thus connected up to the new system of drains for the whole of Windhill, which provides drainage facilities for a population of about 8000. Many of the works involved in thus collecting the sewage at the outfall are of a varied and interesting character. The whole system, indeed, forms an epitome of the difficulties and dangers of constructing sewers through an intricate network of buildings, which, in course of time, have been allowed to cover the only natural line of drainage, alongside the river and streams of a busy manufacturing district. Nine-tenths of the sewage conveyed by the main outfall sewer discharges into a tank sewer holding 275,000 gallons, whence it is lifted 47 feet by electrically worked pumps into triplicate settling tanks with a capacity of 50,000 gallons, being joined at the well head by the sewage which flows by gravitation from the Windhill district, amounting to about 10 per cent. of the entire volume. From these tanks it flows into eight bacterial beds arranged in two tiers or rows of four coarse and four fine beds on the double contact system. The coarse tanks have a bottom fall of 6 inches, and are filled to a mean depth of 3¼ feet with coarse clinkers or engine ashes of 3 or 4 inches diameter. The fine tanks are filled to a like depth with the same material crushed and sifted to about 1 inch down to ¼-inch gauge. Thus, taking the net working capacity in sewage volume as one-third of empty filter, the capacity of each coarse filter is 48,125 gallons, or a total of 192,500 gallons, and being filled three times per twenty-four hours, the total volume which can be dealt with daily is 577,500 gallons. A supply conduit 4 feet by 18 inches extends along the head of the tier of tanks, and the sewage is admitted to and discharged from each tank by four sluices. The effluent conduit of the same size extends along the foot of the tanks, and brings the effluent to the land filter, which is about 12 acres in area.

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These conduits are made with flat inverts of cement concrete. The walls are red brickwork in cement, the bricks being of special quality from Lancashire, almost vitrified in texture. After filtration through the land the purified effluent is gathered into an open drain with ledges 6 inches wide on each side at 3 feet above the invert. Over these ledges the subsoil drains project 3 inches at every 30 feet or so, and samples can be taken to prove the efficiency or otherwise of every part of every bed, and also the discharging efficiency of each subsoil drain. Thus there is complete control of the whole results. The effluent drain discharges into the River Aire, which, at this point, is at present a black fœtid sewer owing chiefly to the discharge of sewage and trade refuse from neighbouring districts. To relieve the tanks and the land areas in times of heavy rain a storm-water conduit is provided to take the sewage, after a dilution of 2 to 1, from the settling tanks, to a special filter of engine ashes 2 feet thick and 3 acres in extent, with 4-inch subsoil tile drains and 6-inch "seconds" fireclay pipes for drainage. The principle of discharging every drain into an open conduit is here also observed, the engineer (Mr. Paterson) being convinced that nothing so much conduces to the maintenance of the efficiency of works of this nature as the provision of full means for detecting their defects. This filter and the land filter beds discharge by separate tail-bays into the river. The levelling of the 3 acres for the storm-water filter required an excavation of nearly 10,000 cubic yards of earth.

The works here described do not entirely meet the requirements of the Local Government Board, who are insisting upon the provision of more bacteria beds, so that it will be possible to treat three times the dry-weather flow of the sewage of the district. Plans and estimates for these extensions are being submitted for the approval of the authority in London. In considering the method of sewage treatment adopted at Shipley, and the results obtained, it should be borne in mind that the Council have the advantage of having to deal with domestic sewage only, trade refuse being excluded from the sewers. Owing, however, to the bulk of the sewers of the district being on the combined system, there is a large collection, not only of storm water, but also of water from the springs in the district, which discharges into the outfall sewers, and has to be treated along with the domestic sewage. This is the state of affairs

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to-day; but the Council have in contemplation the ultimate conversion of the whole of the sewers into a separate system, so that surface and spring water may be run by means of special sewers direct into the river. When plans were originally prepared for the sewage outfall works, the question of providing destructors came under the consideration of the Council, and it was ultimately decided that these should be erected on the same site as the outfall works. After plans for the destructors and engine house had been submitted to the Local Government Board, the Council considered it would be an advantage to have electricity works also on this site, in order that the steam raised by the burning of the refuse (over and above that required for sewage pumping) might be used in this direction. The result is that Shipley holds the almost unique position of having sewage outfall works, refuse destructors and electricity works upon the same site. The destructor is of the Meldrum regenerative type, consisting of furnace, combustion chamber, Lancashire boiler and regenerator. Refuse is tipped into the adjoining hoppers, then withdrawn from the bottom by hand, and fed into the furnace opposite. The cells are so arranged that the fire is continuous over the whole surface of the grate, the forced draught being localised by closed ashpits. By this method any part of the grate can be worked singly, or any part shut off whilst the remainder are in use. The air for the blast is heated by being passed around cast iron pipes, through which the gases from the boiler flues are directed. The temperature of the air, as it enters the destructor, varies from 280° to 350°, 320° being the average. Another advantage of the open grate is the mingling of the gases from the duller and brighter portions of the fire, thus giving a better and more even combustion in the furnace itself. After passing over the furnace bridge the flames and gases enter the combustion chamber, and the temperature obtained therein is so high that the deposited dust is fused into solid clinker. The maximum capacity of the destructor, with average ash-pit refuse, is 50 to 55 tons per twenty-four hours. At Shipley there is not more than an average daily supply of 25 tons, and this, of course, is easily disposed of. It would obviously be an advantage if the supply of refuse was more nearly equal to the capacity of the destructor, but that is a matter which the future expansion of the district will put right. The boiler-house equipment also includes a

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Green's economiser with 192 tubes, and a second 30 feet by 8 feet Lancashire boiler, to which is attached one of Dixon's patent super-heaters. To revert to the destructor itself, it may be said that hand-firing is considered preferable; in fact the success or failure of a destructor depends largely upon the individual attention of the workmen who have to do the firing. Only by the workmen exercising discretion in this matter can the best results be obtained. In this way the wet privy refuse can be mixed with the dry refuse, and the whole of the worst description of the material to be dealt with is got rid of, whilst at the same time the heat is kept fairly even throughout. The refuse burnt at Shipley, which for steam raising is equal to about one-tenth best steam coal, averages about 600 tons a month, but were the refuse obtainable it would be quite possible to consume 300 tons weekly in this four-cell destructor. The most difficult kind of refuse to deal with is that from the abattoir, and the Council have decided to purchase a special offal hopper similar to the one in use at Nelson, so that this very offensive refuse will not have to be handled by the workmen. The engine-room plant consists of two Parsons' turbines direct coupled to two 240-kw. compound-wound direct current generators, suitable for running on either traction or lighting circuits; one 45 I.H.P. reciprocating engine direct coupled to a 25-kw. compound-wound generator, which can be run on either side of a 3-wire lighting system, and was originally intended for driving the smaller sewage pump; storage battery, 260 cells, Victoria type, 17 plates, supplied by the British Power, Traction and Lighting Company; a 3-wire lighting switchboard by Mavor and Coulson, of Glasgow, comprising six generator panels, four feeder panels, two battery panels, and centre panel carrying neutral bus-bar and small recording ammeter for registering earth leakage from the mains. The traction switchboard consists of feeder panels for two 0·4 and one 0·6 positive feeders; battery booster panels, negative booster panels, motor generator panels and Board of Trade panel with the usual complement of starting switches, rheostats, ammeters, volt-meters, recording instruments and kilowatt-hour meters, for registering the supply of current for traction purposes. There are also a 60-kw. traction motor direct coupled to two 25-kw. lighting generators, which can be used for supplying traction current from the lighting side, lighting current from

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traction side, and also run as an ordinary balancer; reversible battery booster driven by motor off the traction bus-bars for equalising the load on the traction generator. (This set is intended to keep an approximately constant load on the traction generator the whole of the time it is running.) In addition to these there are two negative boosters driven by shunt-wound traction motor for keeping the voltage drop in return feeders within the Board of Trade limit of 7 volts. A special board controls the works lighting and motors (including those driving the sewage pumps). The special change-over switches are mounted on this board, so that any out-of-balance current in the town may be compensated for at the works. An independent condensing plant, with steam-driven air-pump and motor-driven circulating pump is in use, capable of dealing with 10,000 lbs. of steam per hour. The sewage pumping plant comprises a 9-inch Gwynne's centrifugal pump direct coupled to 66 B.H.P. compound-wound "Castle" motor, and 7-inch Gwynne's pump coupled to 30 B.H.P. motor supplied by Messrs. Wilson Hartnell, Limited, of Leeds. The 9-inch pump has a maximum duty of 2200 gallons per minute, and the 7-inch pump 1200—a total pumping capacity of 3400 gallons per minute. It would be a very exceptional flow that required such a capacity. The electrically driven centrifugal pump is very effective as regards speed regulation, seeing that a very slight difference in the speed makes a very material alteration in the output of the pump. The regulating switch in series with the shunt-winding of the large motor varies the load from 90 to 200 amperes at 240 volts, and the output of the pump in the same proportion. The arrangement of the suction pipes is very effective, and well worth inspection.

From this brief outline of this plant, it will be seen that the object of the Council was so to combine the three works—destructor, sewage pumping and electric lighting—that there could not only be utilisation of the steam produced by the burning of the ashpit refuse, but that there should be economy in management. The policy of combining an electric lighting and tramway supply station with a destructor and sewage disposal works was quite unique, and has much in its favour. The same staff and the same management suffice for all the undertakings. The mechanical work and superintendence involved in the pumping station is very little addition

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to the work of following the engines, dynamos, pipe work, boilers and pumps of the ordinary central station type. The advisability of at all times using steam raised by the destructor in the electricity station is a very debatable question. With the lighting station alone, apart from a motor load, very little steam is required during the day, the bulk of the demand being confined to the hours between dusk and 9 p.m. The most economical way of working a destructor is to equalise the work during the whole of the twenty-four hours, and it is an obvious saving when it is possible to bring on, as at Shipley, a day load in the shape of traction and motor supply, which utilises the steam during the whole of the day, when the bulk of the refuse is being dealt with. The sewage pumping load can be and is used to equalise the load on the lighting network, which, again, also provides a regular load for the destructor. The increased demand for current for traction, motor and lighting purposes, has, of course, necessitated the use of the second Lancashire boiler for steam production, but has resulted in a saving in the cost of working the destructor. When the destructor was started, it was run on eight-hour shifts seven days a week. It was afterwards dropped to six days a week, and then altered to two shifts a day, the fires being banked up from 11 p.m. to 4 a.m. At present steam is raised by the coal-fired boiler from 4 p.m. to 7 a.m., and then the destructor runs the day load until 6 to 10 p.m. according to the quantity of refuse to be destroyed.

An electrical engineer would always prefer to raise his steam from coal rather than from a refuse destructor; but it would be folly for a town the size of Shipley to allow steam power raised by the destruction of refuse to be wasted. On the whole, the success obtained at Dockfield has been very gratifying, and even better results are hoped for when the different units can be run on full load instead of being run at quarter load or even less than that, and at times have been actually run non-condensing in order to utilise the steam and get rid of the refuse.

The electrical plant at Dockfield has been designed by Mr. Quin; but the whole of the works, comprising destructor, sewage outfall pumps, and electrical station, are now under the control of Mr. S. D. Schofield, A.M. Inst. E.E., the Council's Resident Engineer.

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DISCUSSION.

Mr. A. D. GREATOREX: I should like to congratulate the Shipley Council upon having got rid of most of the privies in connection with the houses. It must be an advantage to the inhabitants, because if there is an abomination it is the old-fashioned system of privies. If the Author could give us the cost of purchase of the existing tramways it would be useful. I am glad to see that Mr. Quin's patent cut-out is used on the tramway system, as it entirely does away with any danger from a trolley-wire breaking. As regards the sewage question, I think if the size of the beds could be added, how long they have been in operation, and, if any analyses have been made, the results obtained, from a chemical standpoint, it would greatly add to the value of the paper. The effluent I examined this morning is a very good one, good enough to discharge into any river. Indeed, in this case, it is a pity the river could not be submitted to bacteriological treatment. It would also be interesting to know the cost of the beds per square yard. One has to be governed by price of materials and so on, but it is interesting to know the cost per square yard in different parts of the country. Another question is the cost of the material. Judging from the material seen this morning, it is not very expensive. I should like to know if any gaugings have been taken, or measurements made, as to the present and the original capacity of the beds. From my own experience, with a somewhat similar material, the capacity of my beds has been brought down by something like 43 per cent. I should fancy the same thing has happened here. Still it will not be an expensive thing to take out the material, sift it, and put it back again. Another point I am deeply interested in, and one I came to Shipley specially to see, is the arrangement for pumping the sewage by electrical pumps. I should like to know the cost of pumping per thousand gallons; also the cost per ton of disposing of the town refuse. I feel sure the Author will pardon me for asking these questions. I must congratulate him—not being an engineer or an expert—upon the very excellent way in which he has compiled the paper, which says much for the amicable relations which he must have with his brother officials.

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Mr. E. J. Silcock: After seeing the works we have seen to-day it must strike us all as being somewhat strange that Shipley was unable to obtain its charter of incorporation. I hope I shall be able to see that charter granted before long. Turning to the details of the paper, Mr. Greatorex has named most of the points upon which further information would be of value. With regard to the water supply it occurs to me, from the figures given, that probably the storage capacity which is provided by the Shipley Council will have to be increased in the near future. I have some knowledge of the district and the rainfall, and I am under the impression that a storage capacity of 120 days' consumption is decidedly low for the rainfall available, and that the storage capacity will have to be increased up to 200 days of the daily yield of the valley, or about 200 million gallons exclusive of compensation. The consumption of water per head per day is stated at 30 gallons, which seems to be high in a town of this description where manufacturers take their supply from other sources than the public supply. I understand the domestic consumption is equal to 25 gallons per head per day. That is a high figure, and is probably accounted for by the fact that the Council allow the use of a bath and one water-closet free of charge. That is the proper course to adopt, because the greater the facilities given to people to keep themselves and their houses clean, the better their health is likely to be. Every house, I think, should be provided with a bath. In Leeds, they are practically now constructing all cottages above a rental of 4*s.* 6*d.* a week with baths, and I think that provision will be extended to houses of a smaller class before very long. The abattoir which we saw to-day seems to be a very good and useful institution, and I am sure Mr. Jackson, the designer of that work, is to be congratulated upon the results produced. And I think the Council are to be congratulated upon the fact that they were able to close the private slaughter-houses without paying compensation. The great difficulty in most towns is to get the butchers to see that they will not be damaged by taking their beasts to a public slaughter-house to be killed. There is no doubt from a sanitary point of view the public slaughter-house must be the best, because it offers such great facilities for the inspection of all the carcases dealt with there, and it does away with the

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combination of two trades sometimes carried on together—the knackers' yard and the slaughter-house. Where you have all sorts of animals taken to a private slaughter-house to be slaughtered, there is a great temptation to cut off and use some of the best joints from diseased animals, to say nothing of sausages. There is just one point with regard to tramways. The Author says that the engineer, Mr. Quin, looks upon the life of the joint as the life of the rail, and I think we shall all agree with him that that is so. Information as to the joint adopted would be useful. Turning to the sewerage works, we are told, by a financial statement which has been circulated, that a very large sum has had to be paid for the item of easement, and knowing the Shipley district I can well imagine that to be so, because the town, as happens in all these Yorkshire valleys, has been built upon the river, and the first mills were constructed upon the river banks; and as the valleys are very narrow and very steep it is almost impossible to construct a sewerage scheme without passing through the mills and mill-yards in the lower part of the valley near to the river itself, so that compensation for large amounts for small lengths have to be paid. I have heard that Shipley is in that position, and I know they have had one or two arbitrations which have cost large sums. That accounts for the large cost appearing in the financial statement for easement. I should like to know the amount of sewage dealt with, and also to have some definite information as to the character of the sewage. When at the sewage works this morning, I went to the screening tank and saw a good a deal of steam coming out, and it occurred to me that that did not come from domestic sewage. The material which is used in the bacteria beds is obviously the material which would be used, because you have the destructor there to produce clinker, but I quite agree with Mr. Greatorex that a better material would be found the cheapest in the long run. I think it will be found if bacteria beds are to be continually used that something harder than clinker or coke will have to be used, because the breaking down of the material is so great, that the capacity of the beds is reduced by practically 50 per cent. There is no doubt that material more in the nature of granite or, perhaps, the best thing is basalt lava, although more costly in the first instance, will turn out to be the

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cheapest in the long run. The effluent appears to be a good one, and we should like to know the result of the chemical analysis. The Rivers Board are very active and do their best to keep the rivers in good condition, but when one sees here the river and the sewage effluent, one cannot help feeling that it would be an injustice to produce the high class effluents which are necessary when you are dealing with the Thames and Severn and other rivers from which water is taken for domestic consumption. The river Aire can never again be used for drinking water below Shipley, and to ask the authorities to produce a high-class effluent would be something in the nature of a waste of money.

Mr. C. F. WIKE: With regard to tramways; the question of joints is an important one. In Sheffield we have, during the last four or five years, constructed tramways for overhead electric traction, with a length of about 50 miles single track. Up to the present no special joint has been used, but the fish-plates are longer than usual—about 3 feet. On the whole the joints have stood very well, but they are now showing signs of wear, and in time no doubt we shall find it advisable to adopt some means of strengthening them. One would like to know from other engineers who have constructed tramways what their experience in this respect has been. In reply to an inquiry about your sewage, I was told that no trade effluents were admitted to the sewers, which must be a great advantage, especially as regards the bacteria beds. In Sheffield for four years or more I have been carrying out experiments with different methods of bacteriological purification, and we have at present from 2½ to 3 acres of experimental filters divided into coarse and fine beds. The results from a chemical point of view are practically perfect, that is we obtain about 95 per cent. of purification. Coke was the first medium we tried, but in more recent experiments we have used destructor ash, and the chemist at the works, who is constantly analysing the effluents, thinks it gives slightly better results, though as the percentage of purification is already so high, the improvement cannot be a great one. The depth of the beds is about the same as in Shipley —5 feet for the coarse beds and 3 feet 6 inches for the fine beds —and the effluent has proved satisfactory to the West Riding Rivers Board. Recently a septic tank has been constructed, the effluent from which is subsequently treated by double contact

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and other modifications of the system are also being tested. The sewage treated experimentally is equal in quantity to that of a town of about 30,000 inhabitants, and though I am not at present in a position to give more details, or figures as to cost, I hope at some time to bring the subject of sewage treatment more fully before the Association. Before leaving the sewage question I should like to refer to the difficulty of separating the surface and spring water from the sewage. Members connected with Yorkshire towns will know that many of the old water-courses have, in process of time, become practically sewers, which means that a large quantity of pure water has to be conveyed to the works and there dealt with. This makes the question of expense a very serious one. With reference to the destructor. Much depends upon the man who has charge of the stoking; he is often able to make the destructor successful or otherwise. He may force matters and so get a larger daily tonnage per cell, but in such cases the fabric must suffer, and I know of cases of this kind which have actually happened.

Mr. G. T. LYNAM: It would be interesting to know the character of the effluent from each part of the process—the tanks, the coarse bed, the fine bed, and also the land.

Mr. C. LUND: I should like to ask the amount of water evaporated per pound of refuse by this destructor.

Mr. J. POTTS (Chairman of the Sanitary Committee): It may seem strange to many of those present, that we in Shipley should pump almost the whole of our sewage, when other towns in the Aire valley get theirs to the outfall by gravitation. About four-fifths of the sewage has to be pumped. One of our engineers has expressed the view that we could get the sewage by gravitation on to ground where it could have been treated. Mr. Greatorex congratulated us on having got rid of the bulk of our privies. But actually we have not, and we have still to deal with them. We have converted about a thousand of our wet ash-pits, and the process of conversion is still going on. It was originally planned that the bacteria beds should be double the present size—the coarse beds are 100 feet by 66 feet, and the fine beds 100 feet by 72 feet. The beds have been working for eighteen months satisfactorily. They are able to cope with almost the whole of the dry-weather flow, and we thought it only reasonable before we made any extension, or went in for a complete scheme, that we should know the duty of these beds.

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Unfortunately for us the Local Government Board demand that we should put down beds which will cope with three times the dry-weather flow.

The PRESIDENT: So far as pumping is concerned, it is entirely a matter of levels. The engineer advised the Council upon a certain scheme, and it was far better that the Council should accept that advice.

Mr. LINDOW: The cost of disposal of our town refuse is rather high. We have to cart it a long way, and I think the average cost of collection and disposal runs to 3*s*. per ton. When we get rid of our wet ash-pits we shall reduce it considerably. Mr. Silcock has referred to the storage capacity of the reservoirs. The Council are fully alive to the importance of increasing the storage capacity, and if they can ensure a dry-weather flow of water into the reservoir they can settle the difficulty. But that, as you know, is an engineer's question. The only novel feature in the construction of the tramways is the employment of a steel sole-plate under the points of the same section as the rail. It does seem to provide all that is possible in the way of strengthening the line and adding to the life of the rails. That is Mr. Quin's practice here, and the joints are very satisfactory. We are quite aware that the sewerage of the district is going to be a very expensive matter to us and that we have not done yet. Mr. Paterson is preparing an extension of the beds. The Local Government Board insist upon this being carried out. We spent 10,000*l*. in easements and law expenses—an expense we could not avoid. We have had no difficulty in obtaining borrowing powers, except that the Local Government Board make a strong point of compelling you to do all they desire. We possess power to compel the laying of separate sewers in the streets; we have that power under our Act of last year. We do not pass plans for new streets without separate sewers, so that ultimately we can connect with the surface water drains. We have instructed an analyst to take samples and to prepare a series of results, which I shall be very pleased to arrange for publication if so desired.

Mr. PATERSON: The original scheme of the Shipley Board was to take in manufacturers' refuse as well as domestic sewage, and for that purpose they contemplated chemical precipitation in tanks and land treatment. When the Council decided to go in for bacterial treatment of the sewage they determined to keep

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trade effluents out, as they were advised they would be a serious obstacle to the success of that system. That has had a considerable bearing on the question of easement. The cost of easements has exceeded 8200*l*. There is a great difference whether you take a manufacturer's effluent, or refuse it and leave the manufacturers to deal with it at their own cost. With regard to the surface water, I may say a considerable part of it is separated from the sewage. In one district—Windhill—with a population of 8000, practically the whole of the surface water goes into the old sewers, and the sewage goes into the new sewers. The surface water of a further 2000 was kept out of the sewers, and the remaining 14,000 were sending all into the sewers. The design for the bacterial system of treatment was furnished by Mr. Dibdin. In reply to Mr. Greatorex, I may say we have no means of measurement of the capacity of the beds. One reason is we are not yet fully connected; we have at present about six-sevenths of the district connected. When the whole district is connected, and the scheme completed, I shall advise them to put down meters so as to check the diminution of capacity. With regard to distribution, Mr. Dibdin had his own way. I think that a careful distribution over the whole area of the beds is a very desirable thing. There are no complications, no sprinkling, no percolation through pipes which get stopped up. The Manchester system is probably the most effective way of obtaining an equal distribution. The cost of construction, roughly speaking, is 17*s*. 6*d*. to 18*s*. per square yard.

Mr. GREATOREX: Does that include material?

Mr. PATERSON: Yes, I may say that is based upon actual cost. The contractor did not carry out that part of the work: the Council decided to fill in the beds themselves. As to the cost of pumping per thousand gallons, until the scheme is completed I do not suppose there will be any trustworthy information upon that point. Mr. Dibdin in his book suggests one acre of beds per million gallons. We have two acres and are going to increase the area. The Manchester people have one acre to 283,000 gallons, with a more difficult sewage mixed with manufacturers' refuse. Mr. Silcock spoke of the disintegration of clinker in the beds. There is no doubt a good deal of clinker, if it is not properly burnt and does not form a considerable quantity of pure silica, will break up. Therefore I agree with

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him that it is probable a better material will have to be found. Shipley is probably in as good a position as any district in possessing a cemetery almost entirely composed of boulders. These boulders are chiefly of millstone grit. That material will make a very good media for bacteria beds, and the Council have almost any quantity of it on their own ground. So far as the Rivers Board are concerned there has been no complaint made as to the quality of the effluent water from the sewage works. I was very glad to hear Mr. Wike say that he has had perfect results from the experimental bacteria beds at Sheffield.

Mr. PATERSON: I also agree as to the complications which would arise from any attempt to carry out the separate system to its logical conclusion—that is to separate the whole. Some remarks were made by Mr. Pitt as to a gravitation scheme. I placed the design of a gravitation scheme before the Shipley Council, but it meant going down the valley three miles below Shipley.

Mr. SCHOFIELD: I think nearly the whole of the points raised in the discussion have been dealt with by Mr. Lindow and Mr. Paterson. With regard to the tramways, H-shaped girders are in use, 2 feet 6 inches long and 6 inches deep. The centre of the girder is put in the junction of the two rails, so as to get a better spring and prevent buckling as the cars pass over. The cost of wages per ton of refuse treated at the destructor is about 1*s.*, some weeks more and some weeks less, according to the quantity to be dealt with. The cost in current alone for the sewage pumps works out at ·36*d.* per thousand gallons.

Immediately following the reception by the Chairman of the District Council, the Members attending the meeting paid visits to the abattoirs, electric light works, the destructor and the bacteria beds. They thence proceeded in brakes to the Saltaire Mills, where an opportunity was afforded of inspecting the engine and one of the large weaving sheds, with a floor space an acre in extent. Mr. Robert, Chairman of the Saltaire Company, and Mr. W. Hird, acted as guides to the party. The Members were entertained to luncheon at the Saltaire Institute, Mr. Councillor Shaw presiding.

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MIDLAND DISTRICT MEETING AT WEST BROMWICH.

September 27, 1902.

Held in the West Bromwich Institute.

T. H. YABBICOM, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Mayor (Mr. Councillor J. H. Chesshire) received the Members and offered them a hearty welcome to West Bromwich.

The President, on behalf of the Association, thanked the Mayor for the kind welcome he had given them.

The minutes of the last Midland District Meeting were read, confirmed and signed.

Mr. J. S. Pickering (Nuneaton) was unanimously re-elected as the Hon. District Secretary.

The following paper was then read and discussed:—

MUNICIPAL WORK IN WEST BROMWICH.

BY ALBERT D. GREATOREX, ASSOC. M. INST. C.E.,
BOROUGH ENGINEER AND SURVEYOR.

IT is not the intention of the Author to weary the Members with a mass of general information; suffice it to say that West Bromwich is well supplied with the various Public Institutions so necessary for a well governed town, such as a Town Hall, Law Courts, Free Library and Institute. Here, in passing, mention might be made of the New Art School, the generous gift of Mr. G. H. Kenrick, of the firm of Messrs. Archibald Kenrick and Sons of West Bromwich, just completed from the

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design of Messrs. Wood and Kenrick, architects, of this town, which school is one of the most complete and up-to-date of its kind in the country, affording every facility for the teaching of arts and crafts; also the historic building known as Oak House, which was purchased and presented to the town by the late Alderman Reuben Farley, J.P., in 1898. The work of restoring the building and laying out the grounds occupied nearly three years, and was carried out under the supervision of Messrs. Wood and Kenrick at the expense of the donor. The building is used as a museum, and is well patronised.

The Council own the gas and electricity works; water is supplied by the South Staffordshire Water Co.; and as regards parks and recreation grounds the town possesses no less than four, having a total area of about 96 acres. Dartmouth Park, area 65½ acres, is held on a nominal rent for a period of 99 years from the late Earl of Dartmouth. Under the care of the superintendent, Mr. H. Browne, the parks are kept in excellent condition. A sum of 21,391*l.* has been expended in laying out the grounds and erecting the various buildings.

Sewerage and Sewage Disposal.

Sewers.—The sewers in West Bromwich vary in size from 5 feet by 3 feet 4 inch brick to 9-inch earthenware, with manholes, lamp-holes, etc. They were constructed from designs and under the supervision of Mr. J. T. Eayrs, M.Inst.C.E., the Author's predecessor. A sum of 120,724*l.* has been expended by Mr. Eayrs in the construction of the sewers, purchase of land for sewage farm, laying out areas, house connections, and other works, up to March 1898. Since that date a further sum of 5,111*l.* has been expended by the Author in under-draining additional areas, erection of bailiff's house, farm buildings, laying on water supply, and construction of bacteria beds, etc., making a total to date of 125,835*l.*

Sewage Disposal.—The sewage farm (Friar Park) is situated in the valley of the River Tame, and is bounded on its northern side by that river, on its western by a small brook which flows into the Tame; higher up on the opposite bank of the river are the outfalls of the Wednesbury Sewage Works, whilst below on the opposite side are the outfalls of the Walsall Farm.

The area of the farm is 230 acres, of a very variable

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character, including agricultural land, woods, waste ground and pit mounds; some portions have been laid out for intermittent filtration and broad irrigation, whilst some portions of the pit mounds have been levelled and are at the present time used for sewage treatment, but with unsatisfactory results.

The sewage is delivered at the farm by two main sewers, a high and a low level, the average daily dry-weather flow of both sewers being: low level 800,000 gallons, high level 400,000 gallons, a total of about 1,200,000 gallons.

The low-level sewage, as is indicated by the analysis of the crude sewage, is comparatively weak, although it contains a certain amount of manufacturers' waste, including waste products from tar distillation works. The Corporation do not allow acid or wash water from galvanising works to discharge into the sewers, the mean of 18 analyses after the removal of suspended matter giving—

	Parts per 100,000.
Oxygen consumed in 4 hours	3·251
Albuminoid ammonia	0·319

It is treated on the intermittent principle on the low-lying areas at the farm, which have an area of about 43 acres, and some portion is also pumped on to two areas at a higher level, which have an area of about 21 acres. This gives a collective area for the treatment of the low-level sewage of about 64 acres.

The high-level sewage is also a dilute one, though of rather a stronger character than the low-level; it is free from admixture with manufacturers' waste except breweries, the mean of 18 analyses after the removal of suspended matter giving—

	Parts per 100,000.
Oxygen consumed in 4 hours	5·034
Albuminoid ammonia	0·626

It is delivered by an 18-inch hydraulic main on to the top of the farm, where there are two small detritus tanks having a capacity of about 25,000 gallons each. The sewage is distributed on the filtration areas, which have been prepared by levelling some of the pit mounds, but this land, as has been already

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pointed out, is entirely unsuitable for the purpose; the sewage percolates through it in dry weather, and in wet weather lies on the surface, thereby creating a nuisance.

The character of the material forming the pit mounds is shown by the appended analysis, and it evidently partakes of the nature of an impure fire-clay, which it resembles in appearance.

SAMPLE DRIED AT 212°.

Silica	56·9 per cent.
Alumina	22·4 „
Iron protoxide	4·65 „
Manganese protoxide	Trace
Lime	„
Magnesia	„
Loss on ignition (combined water and organic matter)	12·20 „
Not estimated alkalies and sulphur	2·85 „
	100·00

Owing to the large quantity of sewage delivered by both levels on the sewage farm, to the great majority of the houses being now connected to the sewers, and to complaints, it was found impossible to deal with the sewage in a satisfactory manner. It was impossible to obtain additional land suitable for the purpose, and it became necessary, if a good effluent was to be produced, that a precipitation scheme or some form of bacterial treatment should be adopted.

In April, 1897, the Author prepared and submitted to the Town Council a report on the then, present, and proposed treatment of the sewage at Friar Park. In this report two schemes were suggested, one a chemical and the other a biological scheme. The working expenses of the chemical scheme appeared so very large, as against the working expenses of a biological scheme, that the Author, in view of the experiments successfully carried out, strongly recommended the Council to adopt the latter, and in October, 1897, submitted a scheme in detail to the Council.

After duly considering this scheme the Committee recommended the Council to approve of the construction of one coarse-grained bacteria bed and one fine-grained bacteria bed on the low level, and one coarse-grained bacteria bed on the high level, at an estimated cost of 1500*l.*, and the under-drainage of certain

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areas at an estimated cost of 2000*l.* The Council, at a meeting on December 1, 1897, approved of the Committee's recommendation. Application was made to the Local Government Board, who held an inquiry on March 3, 1898, and gave their sanction on October 19, 1898, the loan being granted for seven years.

Construction and Details of the Beds.—The construction of the beds was commenced in April 1899, and completed in October of the same year at a cost of 1680*l.*, the work being carried out departmentally.

Low level.—Both the coarse-grained and the fine-grained beds are 120 feet long by 60 feet wide, constructed at right angles to the main outfall conduit, the walls being built of 18-inch brickwork in cement mortar on 6-inch Portland cement concrete foundations, the floor of the beds also being of concrete 6 inches thick, the substrata being clay. The average depth of the filtering material in the coarse-grained bed, which is screened engine ashes from ½-inch to 2-inch mesh, is 3 feet 6 inches, and the average depth of the material in the fine-grained bed, which consists also of screened engine ashes from ¼ inch to ½ inch mesh, is 3 feet.

The sewage reaches the coarse-grained bed by means of three 15-inch penstocks, direct from the main outfall sewer. The troughs for distributing the sewage are of iron, 15 inches wide, laid upon the surface of the filtering medium. The beds are not under-drained, but have six 4-inch sluice valves on either side connected to 6-inch and 9-inch cast iron pipes, which discharge into manholes at the bottom ends of the beds. This system of emptying the beds has been found to be highly satisfactory. The coarse-grained bed discharges into the fine-grained bed, and the fine-grained bed discharges into a 12-inch earthenware pipe, which is connected to a pump well near the engine house, from which the effluent was lifted on to Area No. 11.

Each of the beds has an effective area of 800 square yards, or ⅛th of an acre.

The sewage was turned into the beds on October 3, 1899, and they were worked daily until November 1, from which date the beds received two fillings each per day until November 20; they were filled three times per day until December 5; they then rested until December 12. From this date they have

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received three charges per day (Sundays excepted in all cases) up to November 1, 1900.

In the whole period from November 1, 1899, to November 1, 1900, they received 813 charges of rough screened crude sewage.

High Level.—The coarse-grained bed construction on the high level is 60 feet long by 42 feet wide, adjoining the existing detritus tanks, built in a similar manner to the low-level beds, with an average depth of filtering materials of 3 feet; the sewage passes first through the detritus tanks, then through two 15-inch valves on to the bed, being distributed by means of two 15-inch cast iron troughs; the outlet for the filtrate is by means of six 4-inch valves connected to 6-inch and 4-inch cast iron pipes, discharging into two manholes, and thence by means of a 9-inch earthenware pipe on to Area No. 18, the land taking the place of the fine bed. The area of this bed is 280 square yards, or about $\frac{1}{17}$th of an acre.

The sewage was turned into this bed on September 12, 1899, the crude sewage being first passed through the detritus tanks, and the bed was worked twice in every 24 hours (Sundays excepted) until November 20, 1899, since which date the bed has received three charges per day (Sundays excepted), with the exception of a rest from December 5 to December 12.

In the whole period from November 1, 1899, to November 1, 1900, the beds received 816 charges of crude sewage.

Method of Working the Beds.—The sewage flows into the coarse-grained bed until the water level has nearly reached the top of the material; the inlet valves are then closed, and the bed allowed to stand full during about two hours.

The water is then emptied into the fine-grained bed, and a resting period of equal duration allowed.

The beds are allowed to stand empty for three hours, and are used three times every twenty-four hours.

The final effluent is clear, entirely without odour, remains perfectly sweet on keeping, and is fit to discharge into the river Tame, however small the relative volume.

The object of these beds was to determine whether the sewage of West Bromwich could be successfully treated by the biological system at all times of the year. A further object of the fine-grained bed on the low level was to prove whether the effluent could be satisfactorily purified without any application

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to land, so that by the construction of such beds a saving could be made in pumping.

The beds constructed were so arranged that they would be permanently utilised to purify sewage; consequently, no expenditure on structural works or materials has in any case been wasted or lost.

Analyses.—When the beds were completed, the Committee authorised the Author to have the necessary samples of sewage and effluents in connection with the experimental works analysed by the borough analyst, Mr. H. Silvester, B.Sc., F.I.C.

Method of taking Samples.—The various sewages and effluents were mixtures of samples collected, some half-hourly, and some every quarter of an hour throughout periods to ensure, so far as practicable, the same sewage being analysed throughout the process; and from the analyses made by Mr. Silvester of the numerous samples of crude sewage and effluents which were submitted to him, the Author has compiled the various tables, and prepared the diagram relating to the different analyses.

Low Level.—The average amount of suspended matter contained in the sewage was 77·39 parts per 100,000, or 54·17 grains per gallon, and it will be seen from the average results of these analyses that the matters in suspension in the crude sewage were reduced in the filtrate from the coarse-grained bed to 9·34 per 100,000, or 6·54 grains per gallon, and were still further reduced to 0·95 parts per 100,000, or 0·68 grains per gallon in the final filtrate from the fine-grained bed. The effluent from the land contained traces only.

The reduction of the oxidisable matters in solution was from 3·251 to 1·512 parts per 100,000, and then to 0·457 parts per 100,000, thus showing an average reduction equal to 53·4 per cent. by the coarse-grained beds, and a total reduction equal to 85·9 per cent. by the combined beds. The total purification after land treatment was 88·9 per cent., the oxidisable matter being reduced to 0·360 parts per 100,000.

The reduction of the nitrogenous matters, as indicated by the albuminoid ammonia, was in like manner 47 per cent. by the coarse-grained bed, and 78·6 per cent. by the combined system. The total purification after land treatment was 82·4 per cent.

In addition to the above test, on six occasions samples of the effluents from the fine-grained bed were at a later date sub-

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mitted to the incubator test of the Manchester experts, and the results, which are stated in the following table, are uniformly satisfactory:—

INCUBATOR TEST.

MADE BY H. SILVESTER, B.Sc., F.I.C.

EFFLUENTS FROM FINE-GRAINED BED. LOW LEVEL.

Parts per 100,000.

Before incubation, oxygen consumed in three minutes at 80° F.	After incubation, oxygen consumed in three minutes at 80° F.
0·118	0·065
0·100	0·056
0·108	0·085
0·088	0·075
0·092	0·075
0·084	0·050

Result of Land Treatment of the Low Level Effluent.—The effect of land treatment is to slightly improve the character of the effluent as regards the figures for the oxygen consumed test, and also the albuminoid ammonia test; the figure for nitric nitrogen, however, shows a marked increase after land treatment, rising from 0·447 parts per 100,000 in the effluent from the fine-grained bed, to 1·239 parts per 100,000 in the finished effluent.

It is probable that a small portion of this increased nitric nitrogen is contained in the surface or subsoil water with which the fine bed effluent is very slightly diluted in passing through the land, the average chlorine in the land effluent being slightly lower than the figure for that constituent in the fine bed effluent.

With the provision of adequate detritus tanks, or open septic tanks as proposed in the larger scheme, the Author believes the nitrification in the fine bed will be increased, and the advantages given by the land in this respect will not be so marked. The necessity for good sedimentary arrangements was observed at an early point in the experiments, as it will be noted that the high-level experiments, which are provided with small tanks, gave a better result than the low-level, where no such arrangements existed.

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After November 1, 1900, the beds continued to be worked as heretofore, without any rest beyond the usual Sunday stoppage, but no samples were taken until March 28, 1901. A second series was obtained, in conjunction with the Local Government Board Inspector, on April 25, 1901. The results given by these two sets of samples are shown in the tables given in the Appendix, and the averages are similar to those already calculated from the more numerous analyses.

AVERAGE RESULTS GIVEN BY THE TWO SETS OF SAMPLES.

Parts per 100,000.

Low Level.	Raw Sewage.	Coarse Bed.	Fine Bed.	Land.
Oxygen consumed in 4 hours at 80° F. ..	2·850	1·430	0·600	0·550
Percentage of purification	..	49·81	79	80·7
Albuminoid ammonia .	·369	0·146	0·069	0·068
Percentage of purification	..	60·4	81·3	81·6
Nitric Nitrogen	..	..	0·397	1·833

High Level.—The average amount of suspended matter contained in the sewage was 60·97 parts per 100,000, or 42·68 grains per gallon, and it will be seen from the analyses that the matters in suspension in the crude sewage were reduced in the filtrate from the coarse-grained bed to 6·46 parts per 100,000, or 4·52 grains per gallon, and were still further reduced to 0·66 parts per 100,000, or 0·46 grains per gallon in the final filtrate from the fine-grained bed.

The reduction of the oxidisable matters in solution was from 5·034 to 2·165 per 100,000, and then to 0·369 parts per 100,000, thus showing an average reduction equal to 59·9 per cent. by the coarse-grained bed, and a total reduction equal to 92·6 per cent. by the combined bed and land treatment.

The reduction of the nitrogenous organic matters, as indicated by the albuminoid ammonia, was in like manner 54·6 per cent. by the coarse-grained bed and 93·2 per cent. by the combined system.

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As the chlorine in the sewage is higher than in the final land effluent, a slight correction is necessary to make the effluent strictly comparable with the original sewages. Reducing the sewage and effluent to a common chlorine standard, the percentages of purification are as follows:—

From oxygen absorbed figures 90·7 per cent.
From albuminoid ammonia figures 91·5 per cent.

The better work done by the high-level bed is probably due to the hydraulic main acting as a septic tank, its work being supplemented by the detritus tank, the surface of which was speedily covered with a thick leathery coating.

After November 1, 1900, this bed also continued to be worked as heretofore, and further samples were taken on March 28, 1901, and an additional series on April 25, 1901, in conjunction with the Local Government Board Inspector. These results are shown in the tables given in the Appendix.

These were satisfactory, as will be seen from the averages below:—

Parts per 100,000.

High Level.	Sewage.	Coarse Bed.	Land.
Oxygen consumed in 4 hours at 80° F. .	5·86	2·695	0·340
Percentage of purification. . . .	..	54·0	94·2
Albuminoid ammonia	0·598	0·200	0·038
Percentage of purification	..	66·5	93·6
Nitrates	..	..	0·803

The results have been all that could be desired, and after twelve months' working the beds were in as good a condition, and as free from nuisance, as they were after the first filling.

The analyses show distinctly that the effluents attained such a degree of purity that they could be safely discharged into any watercourse, even should such become dry during the summer. The degree of purification effected is such as to reduce the quantity of organic matter in the effluent to one-third of that generally considered permissible in a first-class effluent, whilst, on the other hand, the degree of aëration maintained by the effluent

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is such that fish can live and thrive in it, the aëration in the effluent after it had been kept for twenty-four hours in a quiescent condition being from 67 to 72 per cent. of the total maximum possible.

Analyses of River Water.—In order to show that the effluents from the bacteria beds are better than the water in the river Tame, and also that they will greatly improve the river, the Author gives the analyses of three samples of river water taken at different times during the carrying out of the experiments, and analysed by Mr. H. Silvester, B.Sc., F.I.C.

RIVER TAME.

—	Chlorine.	Oxygen absorbed in four hours.	Nitrogen as Nitrites and Nitrates.	Ammonia.		Solids in Solution.	Solids in Suspension.	Total Solids.	Rainfall day before.	Rainfall same day.
				Free.	Albuminoid.					
1899										
Nov. 6	16·40	1·180	nil	1·100	0·050	97·0	4·8	101·8	nil	nil
„ 14	17·80	0·848	„	1·520	0·125	103·20	2·8	106·0	„	„
1900										
April 23	36·90	2·553	„	1·440	0·104	196·00	4·4	200·4	„	0·09
Averages	23·70	1·52	..	1·353	0·09	132·06	4·0	136·06	..	..

From the results obtained it is evident that the effluent from the beds is superior to the water in the Tame, and would tend to improve the character of the river.

Effect of Temperature on Beds.—The bacterial treatment has been found to be efficacious at all seasons of the year, the temperature of the sewage being sufficient both to prevent any stoppage of the beds by the forming of ice and also to maintain the necessary activity of the bacteria, even in the coldest weather

Careful daily records have been taken throughout the whole of the experiments of the temperature of the atmosphere, sewage and beds, both when empty and full, and of the effluents.

The following extracts from these records will show at a glance the temperature of the beds and effluents, etc., during the coldest weather experienced whilst the beds have been in operation.

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LOW LEVEL (Coarse-Grained Beds).

1899.	No. of filling.	Time when bed commenced to fill.	Time when filled.	Time when valves opened to commence emptying.	Time when emptied.	Average Temperature of sewage.	Temperature of atmosphere before commencing to fill.	Temperature of bed before commencing to fill.	Temperature of bed when standing full for one hour.	Temperature of effluent.	Temperature of bed immediately after emptying.
December 13	74	2.15 a.m.	3.30 a.m.	5.30 a.m.	7 a.m.	51·0	33·0	49·0	50·0	50·0	49·0
„ 13	75	10 a.m.	11.30 a.m.	1.30 p.m.	3 p.m.	50·0	35·0	49·0	49·0	49·0	48·0
„ 13	76	6 p.m.	7.15 p.m.	9.15 p.m.	10.45 p.m.	51·0	21·0	40·0	49·0	48·0	47·0
„ 14	77	1.45 a.m.	3.15 a.m.	5.15 a.m.	6.45 a.m.	48·0	10·0	42·0	46·0	45·0	45·0
„ 14	78	9.45 a.m.	11 a.m.	1 p.m.	2.30 p.m.	48·0	14·0	34·0	47·0	50·0	34·0
„ 14	79	5.30 p.m.	6.30 p.m.	8.30 p.m.	10 p.m.	49·0	26·0	32·0	47·0	46·0	44·0
„ 15	80	1 a.m.	2.45 a.m.	4.45 a.m.	6.15 a.m.	49·0	23·0	38·0	48·0	45·0	44·0
„ 15	81	9.15 a.m.	10.30 a.m.	12.30 p.m.	2 p.m.	53·0	23·0	40·0	51·0	50·0	40·0
„ 15	82	5 p.m.	6.30 p.m.	8.30 p.m.	10 p.m.	51·0	20·0	46·0	49·0	49·0	48·0
„ 16	83	1 a.m.	2.45 a.m.	4.45 a.m.	6.15 a.m.	49·0	18·0	46·0	47·0	47·0	46·0
„ 16	84	9.15 a.m.	11 a.m.	1 p.m.	2.30 p.m.	49·0	25·0	45·0	47·0	47·0	47·0
„ 16	85	2 a.m.	3.30 a.m.	5.30 a.m.	7 a.m.	47·0	32·0	43·0	45·0	45·0	44·0
					Average ..	49·58	23·33	42·0	47·91	47·59	44·66

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LOW LEVEL (Fine-Grained Bed).

1899	No. of filling.	Time when bed commenced to fill.	Time when filled.	Time when valves opened to commence emptying.	Time when emptied.	Temperature of atmosphere before commencing to fill.	Temperature of bed before commencing to fill.	Temperature of bed when standing full for one hour.	Temperature of effluent.	Temperature of bed immediately after emptying.
December 13	74	5.30 a.m.	7 a.m.	9 a.m.	10.30 a.m.	34·0	48·0	50·0	49·0	48·0
„ 13	75	1.30 p.m.	3 p.m.	5 p.m.	6.30 p.m.	29·0	36·0	48·0	48·0	47·0
„ 13	76	9.15 p.m.	10.45 p.m.	12.45 p.m.	2.15 a.m.	21·0	44·0	47·0	47·0	46·0
„ 14	77	5.15 a.m.	6.45 a.m.	8.45 a.m.	10.15 a.m.	12·0	43·0	46·0	42·0	40·0
„ 14	78	1 p.m.	2.30 p.m.	4.30 p.m.	6 p.m.	20·0	34·0	48·0	46·0	40·0
„ 14	79	8.30 p.m.	10 p.m.	12 p.m.	1.30 a.m.	26·0	45·0	46·0	46·0	45·0
„ 15	80	4.45 a.m.	6.15 a.m.	8.15 a.m.	9.45 a.m.	23·0	44·0	47·0	46·0	45·0
„ 15	81	12.30 p.m.	2 p.m.	4 p.m.	5.30 p.m.	18·0	46·0	49·0	46·0	45·0
„ 15	82	8.30 p.m.	10 p.m.	12 p.m.	1.30 a.m.	20·0	45·0	46·0	46·0	45·0
„ 16	83	4.45 a.m.	6.15 a.m.	8.15 a.m.	9.45 a.m.	19·0	46·0	46·0	46·0	45·0
„ 16	84	1 p.m.	2.30 p.m.	4.30 p.m.	6 p.m.	35·0	43·0	46·0	45·0	45·0
„ 16	85	5.30 a.m.	7 a.m.	9 a.m.	10.30 a.m.	32·0	42·0	45·0	45·0	44·0
					Average ..	24·08	43·0	47·0	46·0	44·58

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HIGH LEVEL (Coarse-Grained Bed).

1899	No. of filling.	Time when bed commenced to fill.	Time when filled.	Time when valves opened to commence emptying.	Time when emptied.	Temperature of atmosphere before commencing to fill.	Temperature of bed before commencing to fill.	Temperature of bed when standing full for one hour.	Temperature of effluent.	Temperature of bed immediately after emptying.	Temperature of sewage.
December 13	74	1 a.m.	2.30 a.m.	4.30 a.m.	6 a.m.	33·0	48·0	50·0	50·0	49·0	51·0
„ 13	75	9 a.m.	10.15 a.m.	12.15 p.m.	1.45 p.m.	35·0	40·0	50·0	49·0	38·0	51·0
„ 13	76	4.45 p.m.	5.30 p.m.	7.30 p.m.	9 p.m.	29·0	39·0	48·0	47·0	46·0	49·0
„ 14	77	12 p.m.	1.30 a.m.	3.30 a.m.	5 a.m.	10·0	40·0	46·0	46·0	45·0	48·0
„ 14	78	8 a.m.	9 a.m.	11 a.m.	12.30 a.m.	13·0	34·0	49·0	49·0	42·0	49·0
„ 14	79	3.30 p.m.	4.45 p.m.	6.15 p.m.	8.15 p.m.	24·0	32·0	51·0	49·0	48·0	52·0
„ 15	80	11.15 p.m.	1 a.m.	3 a.m.	4.30 a.m.	26·0	42·0	47·0	46·0	45·0	49·0
„ 15	81	7.30 a.m.	9 a.m.	11 a.m.	12.30 a.m.	23·0	46·0	49·0	49·0	48·0	51·0
„ 15	82	3.30 p.m.	4.30 p.m.	6.30 p.m.	8 p.m.	20·0	49·0	46·0	49·0	47·0	51·0
„ 16	83	11 p.m.	12.30 a.m.	2.30 a.m.	4 a.m.	20·0	48·0	46·0	46·0	45·0	50·0
„ 16	84	7 a.m.	8.15 a.m.	10.15 a.m.	11.45 a.m.	20·0	40·0	50·0	50·0	47·0	51·0
„ 18	85	2.15 a.m.	4 a.m.	6 a.m.	7.30 a.m.	32·0	44·0	47·0	46·0	46·0	50·0
					Average ..	23·75	41·91	48·25	48·0	45·5	50·17

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On no occasion has any difficulty been experienced in working the beds during frost.

The comparatively high temperature of the sewage, even in the coldest weather, is of importance, not only in preventing the choking of the beds with ice, but also because such a temperature is necessary for the exercise by the bacteria for their functions of purification.

Capacity of Beds.—In order to obtain some reliable data as regards the capacity of the beds, a 6-inch Siemens patent water meter was fixed on the outlets to the beds at various dates during the experiments, in order to ascertain the quantity of water dealt with by the beds. The following are the readings at the different periods :—

	Gallons.	Percentage of loss.
High Level. Coarse Bed.		
Original estimated capacity, September 12, 1899	15,750	..
Gauged Nov. 12, 1900, and following days average of twelve readings	9,950	36·83
Gauged Feb. 25, 1901, and following days average of eight readings	8,856	43·77
Low Level. Coarse Bed.		
Original estimated capacity, October 3, 1899	52,500	..
Gauged October 29, 1900, and following days average of twelve readings	29,455	43·90
Gauged February 12, 1901, and following days average of seven readings	29,832	43·13
Gauged October 10, 1901	24,600	53·14
Fine Bed.		
Original estimated capacity, October 3, 1899	45,000	..
Gauged December 10, 1900, and following days average of twelve readings	33,337	25·92
Gauged February 19, 1901, and following days average of five readings	30,888	31·36
Gauged October 10, 1901	25,150	44·12

The Author is of opinion that the detritus tanks provided for in the new scheme will improve the capacity of the beds.

General Conclusions.—The experiments show that the sewage of West Bromwich can be successfully purified by the bacterial process at all seasons of the year, and that the final effluent from the fine-grained bed on the low level is sufficiently

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pure to discharge into the stream without undergoing subsequent land treatment.

Scheme adopted and being carried out.—In November, 1900, the Author reported on the result of the year's working of the experimental beds, and recommended the carrying out of the whole scheme at an estimated cost of 19,000*l.* The usual Local Government Board inquiry was held, and sanction in due course obtained. Contracts have been let to Mr. William Cunliffe, of Kingston-on-Thames, for the construction of the detritus tanks, bacteria beds, and under-drainage of land, to Messrs. Freakley and Co., of West Bromwich, for the supply of material for filling the beds.

The scheme is as follows:—

Low Level.—Three detritus or open septic tanks, each 160 feet by 30 feet, average depth 5 feet 6 inches; total capacity about 500,000 gallons.

Eight coarse-grained and eight fine-grained bacteria beds, each 120 feet by 60 feet, making with the existing ones a total area of 14,400 square yards, and capable of treating 1,600,000 gallons per twenty-four hours on the 8-hours cycle; the effluent from the fine-grained beds to be collected and passed over an aërating bed, having an area of about 1000 square yards.

All flood water up to four times the dry-weather flow to be treated on Areas Nos. 1 to 9 and Areas Nos. 11 to 13, which have been under-drained, and have a collective area of about thirty-four acres. This will allow for the treatment of about 3,000,000 gallons of storm-water per day.

High Level.—The existing detritus, or open septic tanks, will be extended so as to have a capacity of about 240,000 gallons.

Nine coarse-grained bacteria beds, each 100 feet by 60 feet, will be constructed of a total area of 6,000 square yards, and capable of treating about 1,444,000 gallons per twenty-four hours on the 8-hours cycle.

The effluent from the coarse-grained beds will be conveyed by means of a 12-inch earthenware pipe to Areas Nos. 26 and 30, which have been under-drained, and treated by them instead of fine beds; this land has a collective area of about 28 acres; from thence it will pass direct into the brook.

In order to deal with the storm-water, part of Area No. 23

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will be filled with material to form a special storm filter, and will be capable of dealing with 2,000,000 gallons per twenty-four hours.

As regards the storm-water, storm overflows are being provided both on the high- and low-level works for the purpose of regulating the flow; one overflow is arranged so as to come into operation when the sewage is diluted with more than five times its volume of storm water (i.e. when the sewage is flowing at a rate exceeding six times the dry-weather flow), and another being arranged so that the sewage and storm-water up to twice the dry-weather flow will pass to the filter beds, and thence on to the land, and the balance between twice and six times the dry-weather flow to the areas proposed to be reserved for the treatment of excess storm-water.

At the low-level works the first overflow is placed at the point B on General Plan, and the second overflow just above the detritus tanks at the point C; on the high level, the first overflow is at F, and the second at G.

Construction of Tanks and Beds.—The detritus tanks are constructed with blue brick walls in cement on concrete foundations, and provided with scum-boards and cast iron inlets; the outlet carrier conveys the sewage to the coarse beds.

The bacteria beds are constructed in Portland cement concrete, 6 inches thick, with cast iron outlet valves at regular intervals instead of under-drains.

Material for Filling the Beds.

In West Bromwich there are some old blast furnace slag mounds, which are being worked for ballast purposes, etc., and as the slag can be obtained very cheaply, graded to any size, there will be considerable economy from its use as a filling material.

A furnace in blast is also close at hand, producing a hard slag that does not disintegrate. Dolomite is used as the flux in this particular furnace instead of limestone, and the physical character of the slag is altered by the substitution of magnesia for a portion of the lime; previously when using limestone, the slag readily slaked, whereas with the dolomite flux a hard slag is obtained that does not weather.

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The materials have the following composition, according to analyses made by Mr. H. Silvester, B.Sc., F.I.C.:—

—	Material from old slag mound.	Blast furnace slag, furnace using dolomite.
	Per cent.	Per cent.
Silica	49·60	34·80
Alumina	11·57	10·83
Iron protoxide	3·08	0·51
Manganese protoxide	1·40	1·40
Lime	23·78	26·78
Calcium sulphide	1·84	5·44
Magnesia	3·45	19·90
Combined water and organic matter ..	3·40	..
Moisture lost at 212° F.	0·60	..
Alkalies, etc., and loss	1·28	0·34
	100·00	100·00

The beds are to be filled with the blast furnace slag ½ inch to 2 inches for the coarse beds, and from $\frac{1}{16}$th inch to ½ inch for the fine beds, the weight and cost of the materials being as follows:—

Coarse material, 15 cwts. to the yard, cost 3*s.* 6*d.* per square yard in the low-level, and 4*s.* per square yard in the high-level beds. Fine material, 17 cwts. to the yard, cost 4*s.* per square yard in the low-level beds. The troughs for filling will be 15-inch earthenware, specially made by Messrs. Hamblets, of West Bromwich.

The cost per square yard of the coarse beds on the low-level complete, including filling, is 14*s.*, and the fine beds 15*s.*, and the cost per square yard of area of the high-level coarse bed is 15*s.*

Under-drainage of Areas.—The remaining areas of the farm, namely about 12½ acres, are also to be under-drained. The cost of the under-drainage has been 65*l.* per acre.

The Author is indebted to Mr. Silvester for much valuable assistance during the carrying out of the experiments, and for information given in this paper.

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ANALYSIS OF SAMPLES OF SEWAGE AND EFFLUENTS FROM FRIAR PARK.
BY H. SILVESTER, B.Sc., F.I.C.

Low Level. Sample No. 1093. *March* 29, 1901.

—	Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as nitrites and nitrates.	Ammonia. Free.	Ammonia. Albuminoid.	Solids in solution.	Solids in suspension.	Total solids.	Percentage of purification.	Total percentage of purification.
Raw Sewage	16·1	4·28	nil	6·485	0·456	102	83·2	185·2	..	..
Effluent from Coarse Bed	15·8	2·052	Trace of Nitrites	3·203	0·208	99·6	14·0	113·6	52	..
Effluent from Fine Bed	16·2	0·750	0·171	0·560	0·068	102	Opalescent	102	63·4	82·4
Effluent from Land	12·7	0·650	1·943	0·104	0·068	104·5	..	104·5	13·3	84·8

The matter in suspension consisted of—

Mineral matter (fixed solids)	12·0
Organic matter	71·2

The corrected percentage of purification for the final effluent reduced to a common chlorine standard is 80·34 per cent. The land effluent must have mixed with water containing ammoniacal nitrogen or nitrates ready formed, as the increase in nitrates in the land effluent is more than the free ammonia would allow of in the effluent from the fine beds.

ANALYSIS OF SAMPLES OF SEWAGE AND EFFLUENTS FROM FRIAR PARK.
BY H. SILVESTER, B.Sc., F.I.C.

High Level. Sample No. 1117. *March* 28, 1901. *Parts per* 100,000.

—	Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as nitrites and nitrates.	Ammonia. Free.	Ammonia. Albuminoid.	Solids in solution.	Solids in suspension.	Total Solids.	Percentage of purification.	Total percentage of purification.
Raw Sewage	14·6	18·12	..	8·801	0·722	106	68·0	174	..	..
Effluent from Coarse Bed	15·0	3·97	Traces	5·204	0·290	104·5	24	128·5	56·3	..
Effluent from Land	12·0	0·30	0·969	0·062	0·040	76	..	76·0	92·6	97·5
Effluent from Fine Bed	10·5	1·61	1·178	0·960	0·120	86·5	2·4	88·9	..	..

The matter in suspension consisted of—

Mineral	13·6	parts per 100,000
Organic (volatile)	54·4	" "
	68·0	

The corrected percentage of purification for the final effluent is 95·6.

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Solids in Suspension.	Oxygen absorbed in 4 hours.	Total percentage of Purification.	RAINFALL.			
			Day Samples were taken.	Day before.	2 Days before.	3 Days before.
2·4	0·439	83·7	..	..	0·20	0·26
6·0	0·738	87·9	..	..	..	0·04
43·2	0·283	93·1	..	..	0·05	..
102·0	0·298	95·4	..	..	..	..
79·6	0·944	90·2	..	..	0·34	..
4·0	0·222	69·4	0·03	0·16	..	0·93
66·8	0·432	83·3	0·10	0·15	0·07	0·02
138·4	0·266	96·5	..	0·06	..	..
73·8	0·314	94·4	..	..	..	..
76·4	0·248	89·2	0·15	..	0·26	..
25·0	0·194	87·4	..	..	0·16	0·01
58·4	0·193	98·0	0·05	..	0·02	0·30
57·4	0·146	98·1	0·08	..	..	..
81·2	0·617	83·4	0·01	..	0·09	..
98·6	0·282	95·4	0·10	..	..	..
45·0	0·679	85·5	..	..	..	..
80·0	0·181	92·6	..	..	..	..
59·2	0·170	97·4	0·18	..	0·07	..
60·97	0·369	..	..	..	..	..

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5 AFTER BAVICH. BY HST.

EFFLUENT FRO						RAINFALL.			
gen rbed n urs.	Nitrogen as Nitrites and Nitrates.	Am. Free.	ge. i- n.	Total per-centage of Purifi-cation.	Chlorine.	Total per-centage of Purifi-cation.	Day Samples were taken.	Day before.	2 Days before.	3 Days before.
'35	Traces	2·090	1	77·0	..	..	..	..	0·20	0·26
'31	„	4·200	9	87·7	..	..	..	..	..	0·04
·60	„	1·300	2	67·4	..	..	..	..	0·05	..
500	„	2·900	6	84·2	..	..	..	..	..	..
200	„	3·270	1	88·1	..	..	..	..	0·34	..
380	„	0·800	9	..	13·10	43·4	0·03	0·16	..	0·93
354	„	0·960	6	60·9	14·60	70·7	0·10	0·15	0·07	0·02
359	„	2·260	2	92·1	..	..	..	0·06	..	..
308	„	2·480	4	89·4	..	..	..	..	..	..
'93	„	1·800	2	92·3	19·10	93·6	0·15	..	0·26	..
·11	„	2·960	7	81·0	18·00	90·1	..	..	0·16	0·01
441	„	2·560	0	83·9	19·20	87·5	0·05	..	0·02	0·30
177	„	2·640	4	83·2	18·50	89·4	0·08	..	..	..
313	„	2·234	0	85·1	22·00	88·9	0·01	..	0·09	..
53	„	2·840	0	90·8	23·00	89·5	0·10	..	..	..
23	„	2·240	1	86·5	21·60	86·3	..	..	..	..
61	„	3·808	9	87·0	20·10	90·4	..	..	..	..
27	„	3·394	1	81·9	20·00	86·5	0·18	..	0·07	..
12	..	2·485		..	19·01	..	..	..	..	..

nmonia, and oxyge effluent containingple.
spended matter.

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ANALYSIS OF SAMPLES OF SEWAGE AND EFFLUENTS FROM FRIAR PARK.
BY H. SILVESTER, B.Sc., F.I.C.

High Level. April 25, 1902. *Parts per* 100,000.

—	Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as nitrites and nitrates.	Ammonia.		Solids in solution.	Solids in suspension.	Total Solids.	Percentage of purification.	Total percentage of purification.
				Free.	Albuminoid.					
Raw Sewage	18	3·614	..	4·112	0·474	90·5	58	148·5	..	..
Effluent from Coarse Bed	16·8	1·420	Trace of Nitrites	2·640	0·110	85·4	5·6	91	60·7	..
Effluent from Fine Bed	..	..	..	..	..	..	..	..	..	..
Effluent from Land	14·9	0·381	0·637	0·168	0·035	86·5	2·0	88·5	73·1	89·4

Reaction slightly alkaline. The solids in suspension consisted of—

Volatile matter	42	parts per 100,000
Mineral	16	„ „
	58	

ANALYSIS OF SAMPLES OF SEWAGE AND EFFLUENTS FROM FRIAR PARK.
BY H. SILVESTER, B.Sc., F.I.C.

Low Level. April 25, 1902. *Parts per* 100,000.

—	Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as nitrites and nitrates.	Ammonia.		Solids in solution.	Solids in suspension.	Total solids.	Percentage of purification.	Total percentage of purification.
				Free.	Albuminoid.					
Raw Sewage	15·7	1·420	..	3·056	0·182	107	8·0	115	..	..
Effluent from Coarse Bed	16·7	0·808	..	1·20	0·084	107·4	1·6	109	43·1	..
Effluent from Fine Bed	17·3	0·450	0·624	0·284	0·069	109·1	1·4	110·5	44·3	68·3
Effluent from Land	15·5	0·450	1·724	0·056	0·068	108·6	0·9	109·5	..	68·3
Raw Sewage No. 2	18·6	3·452	..	5·12	0·308	115·5	22	135·5	..	..

Reaction slightly alkaline.
The solids in suspension in the raw sewage consisted of—

Volatile	5·2	parts per 100,000
Mineral	2·8	„ „
	8·0	

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TABLE OF RESULTS OF ANALYSIS OF SAMPLES OF SEWAGE, ETC., FROM FRIAR PARK, WEST BROMWICH.

By Messrs. Dibdin and Thudichum, Analytical and Consulting Chemists.

Quantities stated in Grains per gallon, except organic C and N, which are stated in parts per 100,000.

Date of Collection, April 25, 1901.	Appearance.	Odour.	Reaction.	Chlorine.	Ammonia.		Oxygen absorbed from permanganate at 180° F.		Nitrogen as		Suspended matter		Dissolved solids.		Aëration per cent. of possible after complete aëration and standing for		
					Free.	Albuminoid.	At once.	In 4 hours.	Nitrites.	Nitrates.	Total.	Volatile.	Total.	Volatile.	24 hours.	48 hours.	72 hours.
Raw sewage, low level	Weak Sewage	Weak Sewage	Very faintly alkaline	11·1	1·89	0·157	0·27	1·37	0·0	0·0	7·2	4·8	77·2	18·0	..	..	..
Fine bed effluent, low level ..	Clear	None	„	12·2	0·28	0·042	0·07	0·27	Trace	0·735	slight	trace	76·8	14·4	89·3	83·7	92·7
Final land effluent, low level ..	„	Earthy	„	10·8	0·21	0·039	0·20	0·34	0·0	1·62	No	ne	77·0	20·0	90·0	90·5	71·7
Raw sewage, high level	Sewage	Sewage	„	13·2	4·55	0·420	0·82	4·10	0·0	0·0	70·5	48·1	73·4	24·0	..	..	..
Coarse bed effluent, high level..	Turbid	„	„	13·0	2·45	0·140	0·69	1·92	0·0	0·0	9·2	6·2	57·4	13·0	..	19·3	27·2
Final land effluent, high level ..	Clear	None	„	10·4	0·28	0·014	0·14	0·27	0·0	0·432	No	ne	63·8	18·4	100·0	98·2	76·8
*Raw sewage, low level, 8.15 p.m.	Strong Sewage	Strong Sewage	„	13·1	4·03	0·175	0·89	3·16	0·0	0·0	31·4	21·8	79·6	20·2	..	..	..

* This sample contained no free acid and no appreciable amount of iron salt. The appearance was due to suspended matters, and no dye was detected.

The above results show that the effluent from the fine beds was purified to a point well within recognised requirements, whilst the degree of aëration maintained on standing for 24, 48 or 72 hours was excellent, the oxygen dissolved being more than sufficient to effect the complete oxidation of the remaining organic matters.

The oxidisable matters in the land effluent from the low level were present to a greater extent than in the fine bed effluent, whilst the degree of aëration on the third day was not so high. On the other hand the degree of nitrification was higher.

The land effluent on the high level was practically equal in quality to that of the fine bed on the low level, but the degree of aëration, like that of the low level land effluent, was not maintained on the third day to so great an extent, although it was well above any suggested limit of (50%) fifty per cent.

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Farm Buildings.

The buildings erected at the sewage farm comprise a six-stall stable, with loft, a harness room, loose box, store, cart and implement shed, food mixing house, and leading out of same, a cattle lair for ten head of cattle, and also a large covered shed for cattle.

The building is erected in a substantial but plain manner, the walls being faced with selected common bricks with red quoin, etc., and the roof covered with best red tiles.

Water is laid on from the South Staffordshire Water Mains, and the buildings are drained in the most approved manner, and connected to the low-level sewer, which passes in front of the buildings.

A bailiff's house has also been erected in the same style.

The cost of these buildings and laying on 2-inch water main from main road has been 1500*l.*

Electric Lighting Scheme.

In 1898 the Corporation obtained a Provisional Order for the establishment of an Electric Lighting undertaking. A Committee was appointed, and after they had visited several installations two engineers were requested to submit reports and schemes for their consideration, and in due course Mr. Robert C. Quin, M.I. Mech. E., M.I.E.E., was appointed Consulting Engineer. The compulsory area is the main street from the works to Roebuck Street, a distance of 1¾ miles, with several short streets adjoining the Town Hall.

The system of supply adopted is that known as the continuous current three-wire system, with an electric pressure of 460 volts between the outer conductors, each dynamo having a series winding in addition to its shunt winding, so as to enable it to develop electric pressure up to 560 volts for power purposes.

The generating station is at Black Lake, about the centre of the borough, where five acres of land have been purchased by the Corporation, adjoining the canal.

The buildings, which have been designed and erected under the supervision of the Author to the requirements laid down by the Consulting Engineer, consist of boiler-house, with central

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stack, engine-room, accumulator-room, testing-room and offices. The chimney-stack is situate in the N.E. side of the boiler-house, and is 120 feet from floor level, and built on a concrete foundation, which is 20 feet 6 inches square by 6 feet 6 inches deep; the internal diameter is 5 feet 6 inches, with square base, the base being 3 feet thick and finishing 9 inches on top; from the floor level to 20 feet up it is lined with 9-inch fire-brick; and 20 feet above this 4½-inch fire-brick lining; the flues are arched out of the square base in fire-brick; the outside batter of the circular part of the shaft is 1 in 40, and it is capped by a cast-iron cap weighing 3½ tons, bolted down with holding-down bolts and plates, and has a lightning conductor on top. The boiler-house is 41 feet by 61 feet, and accommodates four boilers and pumps. The roof on the S.W. side is carried on cast-iron columns; the principals are iron, and the roof is slated and glazed with patent glazing.

The engine-room is built in two bays, each 25 feet wide by 62 feet long; the wall adjoining boiler-house is 9 inches thick, with piers at intervals, arched over and carrying on spandril a wall 14 inches thick, with a bed-stone for travelling crane. The engine-room is divided by brick piers, 2 feet 6 inches by 2 feet 3 inches, 10 feet apart, having arches supporting bed-stones for travelling cranes in each section of the building, and the N.E. wall is composed of piers of the same thickness, the arches being temporarily filled in with 9-inch work. The walls of the engine-house, which are permanent, are lined throughout with best cream glazed bricks; the piers and arches are built of best chocolate glazed bricks; the roof principals are iron, and the roofs are match-boarded and slated. The building is well lit from the roof by patent glazing. The end of the engine-house is temporarily filled in with boarding and corrugated iron.

The accumulator-room communicates direct with the engine-room, and is 75 feet long by 18 feet wide, ventilated with electric fans. The battery switch-board is fixed in the wall between the engine-room and accumulator-room.

The testing-room is on the first floor, immediately above the accumulator-room, and is 48 feet 6 inches by 18 feet wide, and communicates with the engine-room directly by means of a balcony and iron staircase, the main switch-board being fixed in the side next the engine-room.

The offices are in the first and second floors, and ample

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accommodation is provided for the present staff, together with lavatory.

The buildings are of a plain but substantial character; the front elevation is faced with King's pressed red bricks; stone sills and heads to windows; the other brickwork is best common of the district.

The cost of the buildings, with chimney and fittings complete, was 5800*l.*, the contractor being Mr. J. Mallin, of West Bromwich.

The present installation of plant in these buildings consists of two dry-back marine boilers, with mechanical stokers, superheaters, etc., two steam turbine-driven dynamos, each of 100 kilowatts capacity, and balancing steam dynamo of 50 kilowatts capacity; there is also an independent condensing plant, capable of dealing with 10,000 lbs. of steam per hour. This is of sufficient capacity for double the present installation of plant. As regards storage capacity, there is a secondary battery of 236 cells in the basement and the usual switch-boards and connections.

The feeding and distributing and pilot cables are laid in earthenware troughs under the footpaths, filled in with an acid and water-resisting and insulation compound, the troughs being covered with hard-burnt bricks. Each cable is laid in a separate and distinct trough, and there is a distance between adjacent cables of six inches. The cables are laid in the footpaths on both sides of the main road from Carter's Green to Beeches Road, and also along several streets near the Town Hall, the total lengths of cables being—

Feeding cables	6 miles
Distributing cables	4¼ „
Pilot cables..	2¾ „

The work of laying the cables was carried out by the Author and Consulting Engineer by direct labour.

The cost of the installation was 30,000*l.*

The charge for electricity for lighting purposes was originally fixed at 6*d.* per B.T.U. for the first hour and 2*d.* for each hour afterwards; but owing to pressure being brought by the Council upon the Committee, the charges were reduced to 4½*d.* per unit until an equivalent of ninety-one hours use of the maximum demand has been reached in each quarter, and thereafter, during the same term, at the rate of 1½*d.* per unit. The charge for electricity for motive purposes is 1*d.* per unit. The standard pressure at which electricity is supplied and

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charged for is 230 volts for lighting, and 460 volts for power purposes. Owing to the low charges, the undertaking cannot be made to pay for the first few years, but the Committee are assured by the Borough Electrical Engineer that when the tramways are in working order the station will be better able to pay its way. The Corporation in their General Bill of 1900 obtained power to suspend the repayment of money borrowed for the purpose of the electric lighting undertaking for a period of two years from the completion of the works, or for a period of two years from the borrowing thereof, whichever shall be the earlier. This is of considerable assistance to such an undertaking.

The number of lamps from May 24, 1901, when the works were ready for supply of current, to September 1, 1902, was equivalent to 7196 8-c.p. lamps, and, when the new Art Schools, Hospital, and other orders are completed, will be very few short of 10,000—a very successful state of affairs, considering the undertaking has only been established sixteen months.

The Corporation obtained powers in their General Bill of 1900 to supply fittings, etc., the clause being as follows:—

"*Power to Supply Electric Fittings.*—The Corporation may provide, sell, let for hire, and fix, set up, alter, repair, and remove, within the Borough, but shall not manufacture, lamps, meters, electric lines, fittings, apparatus, and things for lighting and motive power, and for all other purposes for which electric energy can or may be used or otherwise necessary or proper for the supply, distribution, consumption, or use of electric energy, and may provide all materials and do all works necessary or proper in that behalf, and may require and take such remuneration in money or such rents and charges for and make such terms and conditions with respect to the sale, letting, fixing, setting up, altering, repairing, or removing of such lamps, meters, electric lines, fittings, apparatus, and things, as aforesaid, and for securing their safety and return to the Corporation as the Corporation may think fit, or as may be agreed upon between them and the person to or for whom the same are sold, supplied, let, fixed, set up, altered, repaired, or removed."

For this purpose a loan has been sanctioned for the sum of 10,000*l.*, and in consequence many persons have adopted the light who would under ordinary circumstances doubtless not have done so, or who would have found great difficulty in providing the necessary funds.

The arrangements in force for this purpose are as follows:—

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Any person desirous of having the electric light installed on his premises on the "hire-purchase system" has to sign an undertaking agreeing to pay an annual sum for 10 years, until the said annual payments together shall amount to a sum equal to the cost of installation, when the payments cease and the installations become the property of the consumer.

After making the necessary application, an estimate is given of the cost, and the work is carried out by the department when the actual cost of the installation is ascertained. If the account is paid within twenty-eight days, a special discount is allowed; if paid during the first year 10 per cent., during the second year 7½ per cent., during the third year 5 per cent., and during the fourth year 2½ per cent., but after the fourth year the whole amount is charged.

The cost of installation does not include for lamps; these are supplied and charged on the first account for supply of electricity; the Corporation, however, maintain the fittings, etc. until the end of ten years, or when paid off.

Motors are hired out on fixed charges and maintained by the Corporation.

In order to show the advantage taken of this system, the Author is able to give the following table, which shows the equivalent number of lamps and relative percentage of system as compared with the ordinary method up to August 30, 1902.

—	Equivalent to 8 c.p. lamps.	Per cent.
Lighting consumers on Corporation "hire-purchase system"	3944	54·81
Power consumers hiring Corporation motors ..	1143	15·88
	5087	70·69
Consumers wiring own premises	2109	29·31
Total	7196	100·00

In connection with the supply of energy for the trams a small extension has been made to the Electric Lighting Station by the Author for the accommodation of extra cells and the erection of a tramway switchboard. Two additional boilers are being erected by Messrs. Babcock and Wilcox, also two additional steam turbine-driven dynamos by Messrs. Parsons

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and Co., each machine being capable of developing from 200 to 250 kw. with condenser. There is also to be provided a Highfield reversible booster and a negative booster; these works are being carried out under the supervision of the Borough Electrical Engineer, Mr. J. H. Wray, the estimated cost being 10,000*l.*, a loan having been sanctioned for this amount for a period of twenty-five years.

Tramways.

The tramways in West Bromwich were constructed in 1882, and formed part of the tramway undertaking owned and worked by the South Staffordshire Tramway Company, Limited. Steam power was introduced in 1883.

The lines have a total length of 10 miles 1 furlong 132 yards, and a route mileage of 5 miles 1 furlong 132 yards. There are also single lines with passing places in Spon Lane, and Bromford Lane and Paradise Street, of a total length of 2 miles 1 furlong 156 yards, and a route of 1 mile 7 furlongs 43 yards owned and worked by the Birmingham and Midland Tramway Company, Limited.

In March 1898 a sub-committee of the Highway Committee was appointed to obtain information as regards the various systems of traction, and to report to the Council on the matter generally. After visiting various towns, the Committee recommended the Council to purchase the undertakings, and to reconstruct them for electric traction on the overhead system. In 1900 the Corporation obtained parliamentary powers to reconstruct, equip and work the tramways, and after due consideration the Council decided to lease the lines when constructed and equipped to the South Staffordshire Tramway Lessee Company, Limited, on terms agreed upon between the Company and the Corporation.

Purchase of Existing Lines.—The Corporation paid for the existing lines of the South Staffordshire Tramway Company, Limited, a sum of 32,000*l.*; such sum included compensation for the Company foregoing their rights to sell to the Corporation a portion of the whole of the equipment of their undertaking.

The Corporation also paid to the Company who had leased their undertaking to the Lessee Company a sum of 538*l.* 15*s.*, compensation for loss of rent in respect of that part of the South Staffordshire Tramways situate in the Borough owing to the

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Company selling the lines before they were obliged to do so under the terms of the Provisional Order.

For the lines owned by the Birmingham and Midland Tramway Company, Limited, the Corporation paid the sum of 5,500*l.*

The total cost of purchase, therefore, was 38,038*l.* 15*s.*

After the purchase had been completed the Corporation instructed the Author and Mr. Quin, the Consulting Engineer, to prepare the necessary plans and specifications for the reconstruction and electrical equipment of the various lines. In due course these were submitted to the Council and approved by them, and as part of the agreement was that the Lessee Company should approve of the scheme, they were submitted for their approval, and an arrangement was arrived at between the Company and the Corporation for the work to be carried out at a cost not exceeding 100,000*l.* Contracts were then entered into, and the works are now in hand.

The following are the details of construction:—

Permanent Way.—The rails are of the girder type, 6 inches deep, 45 feet in length, weighing 97½ lbs. to the yard, the chemical composition being as follows:—

Carbon	from ·50 to	·60 per cent.
Manganese	„ ·80 „	1 „
Silicon	maximum	·15 „
Phosphorus	„	·06 „
Sulphur	„	·05 „

The rails are tested for tensile strength: The requirement being that the ultimate tensile strength of the metal shall not be less than 40 tons per square inch, with an elongation of 15 per cent. in a length of 8 inches; and also for tupping test as follows: six lengths from each rolling (each 6 feet long) are taken and tested in the following manner: each is placed on supports 3 feet apart, and a weight of 1 ton is allowed to fall upon the rail at its centre from a height of 20 feet; under these conditions there shall be no fracture of the rail.

The tie bars are made of Staffordshire B.B.B. iron, 1½ inches by ½ inch double screwed.

At each end a modified form of Cooper and Howard-Smith's anchor joint is used, consisting of a 2-foot 6-inch rolled steel joist, 8 inches by 6 inches, of a weight of 35 lbs. to the foot, the rails being bolted to this joist by means of twelve ¾-inch steel

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bolts with shaped heads, malleable iron bevel washers, and helicoid nuts, and the joint is embedded in concrete.

In laying the rails the joints are kept as close as possible, not exceeding $\frac{1}{16}$ inch in clearance, reliance being placed upon the elastic limit of the steel and the strength of the anchor joints to prevent dislocation of the track or fracture of rails.

The steel fish-plates are 19 inches long by $\frac{3}{4}$ inch thick, the chemical composition being:—

Carbon	·45 to ·55 per cent.
Manganese	·6 „ ·9 „
Silicon	·06 „ ·1 „
Phosphorus	·08 „ ·1 „
Sulphur	not exceeding ·06 „

These weigh 32½ lbs. per pair, and are bolted to the rails by four 1 inch bolts with helicoid nuts.

The points, crossings, and drain rails are Messrs. Hadfield's Patent Manganese Steel, of designs made by the engineers.

The permanent way is being carried out under contract by Mr. George Law, of Kidderminster; the existing concrete is left in except in places where it is bad or has been cut up for drainage and other connections. All new concrete consists of one measure of cement, two of sand, and four of broken bricks, slag, or broken concrete, and is 6 inches thick. The new granite setts are 5-inch Mount Sorrell setts; such of the existing setts as are suitable are being redressed and used again. In front of the Town Hall and all places of worship wood paving is being laid. This is of Jarrah and American Red Gum, 9 inch by 4 inch by 3 inch blocks, laid in the usual way.

The rails are bonded with Neptune 000 bonds, two to every joint, and opposite each of the supporting posts (average distance apart 110 feet) all four rails (where double track exists) are cross-bonded together and to the post; where span wire construction holds, the outer rails of each track are taken alternately to one of the supporting poles for the overhead line.

Electrical Equipment.—The poles are of steel, constructed in three lengths, each length of parallel bore; they are inserted into one another for a length of 18 inches and then welded; they are tested by dropping vertically from a height of 5 feet on hard ground, and have to withstand this test without fracture of welding, or splitting of tubes.

The centre poles have a total length of 30 feet 6 inches, of which 6 feet is root. The bottom length is 17 feet long by

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10 inches outside diameter, ½ inch thick; the middle length 7 feet, exclusive of allowance for welding, 8½ inches outside diameter and ·4 inch thick; and the top length 6 feet 6 inches, exclusive of allowance for welding, 7 inches outside diameter and ·3 inch thick. The strength of these poles is such that when treated as a horizontal beam, held rigidly for 6 feet from the end of the larger section, and with a weight of 2000 lbs. supported at a distance of 24 inches from the smaller end, the temporary deflection shall not exceed 6 inches and the permanent set shall not exceed ½ inch.

Every pole of this class is provided with a cast-iron base-plate and an elliptical base (so arranged for the purpose of street lighting). On each of the long sides of the base are cast the coat-of-arms of the Borough and at each end a door.

The bases are provided with a bottom plate bolted to the base and pole, and with space for cables to pass through. Inside the base at each end there are two vertical ribs with cored holes for attaching switch gear.

Each pole is fitted with two 5 feet by 1¾ inch solid steel drawn tubes and wrought-iron scrollwork, cast-iron finial, etc., as shown on the detail drawing.

The straining poles have a total length of 32 feet, of which 7 feet is root. The bottom length is 18 feet 6 inches, 13⅛ inch diameter and ·56 inch thick; the middle length 5 feet 6 inches, exclusive of allowance for welding, 11½ inches diameter and ·43 inch thick; the top length 8 feet, exclusive of allowance for welding, 10 inches diameter and ·37 inch thick. These poles have to stand a strain of 5000 lbs., treated in a similar manner to the centre poles, and have circular bases, etc., of the same design.

The span wire poles have a total length of 31 feet, of which 6 feet is root; the bottom length is 17 feet, 10 inches outside diameter and ·65 inch thick; the middle length 7 feet, exclusive of allowance for welding, 8½ inches outside diameter and ·4 inch thick; the top length 7 feet, exclusive of allowance for welding, 7 inches outside diameter and ·3 inch thick. These poles have to stand a strain of 2500 lbs., treated in a similar manner to the centre poles, and have circular bases, etc., of the same design as the others. Each pole is fitted with two 2 feet 6 inch by 1¾ inch solid drawn steel tubes, having a radical depth of metal of not less than ·25 inch, and each screwed at one end into a malleable iron socket clamp for attachment to the poles. One arm of each pole is formed with a clevis and with bolt for

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span wire attachment; the other arm is provided with a cast-iron ornamental finial; they are also provided with wrought-iron scrollwork, as per detail drawing.

Every pole is drilled with two $\frac{9}{16}$ inch holes 6 inches below the ground level for the purpose of electric bonding.

All the poles and ironwork will be painted on completion.

Trolley Wire.—The trolley wire is circular in section and equivalent to 000 S.W.G. The insulators are of the type shown on details with gun-metal fittings; the section boxes are of special pattern, and each box will contain two of "Quin's" patent automatic safety switches, in order to cut off the current in case a trolley wire breaks or any telephone wires fall on the live trolley wires (for full description of this apparatus see Paper by Ed. Manville, read at Annual Meeting at Leicester, June 27, 1901, vol. xxvii. page 239); with very few exceptions the whole of the telephone wires have been removed from the tramway routes. The boxes also contain telephone apparatus.

Cables.—The feeding cables are placed under the footpaths in socketed earthenware troughs, with blue brick covers, the compound for filling the troughs being composed of dry sand, Stockholm tar and amber resin, and the work of laying the cables has been carried out departmentally under the supervision of the engineers. The length of cable and pilots, etc., is about 25 miles.

STATEMENT SHOWING COST PER MILE, DOUBLE AND SINGLE TRACKS, FOR RECONSTRUCTION AND ELECTRICAL EQUIPMENT OF TRAMWAYS IN WEST BROMWICH.

Permanent Way.	Single Track.	Double Track.
	£ s. d.	£ s. d.
Rails (97½ lbs. per yard), concrete, tie bars, fish plates, joints, points and crossings, paving, etc. The margins are paved for a distance of 2 ft. 3 in. from the rails, and the space between the tracks is 7 ft. for centre pole construction, total width over all, double track 19 ft., single track 8 ft. 4 in.	5,800 0 0	12,000 0 0
Bonding, labour and materials	150 0 0	340 0 0
	Span Wire Construction.	Centre Pole Construction.
Poles, bases and planting	1,930 0 0	1,030 0 0
Electrical Equipment.		Route Mile.
Cables and laying	..	1,560 0 0
Overhead equipment	..	660 0 0

NOTE.—All the above items include for superintendence.

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When the tramways are reconstructed and electrically equipped, the Corporation are under agreement to lease them to the Companies as before stated, the terms of which have been settled between the Corporation and the respective Companies; the Companies in each case providing the cars and taking the current for driving them from the Corporation generating station.

Blue Brick Paving for Carriageways.

At the Annual Meeting held in London on July 8, 1897, Mr. J. T. Eayrs, M.Inst.C.E., Past President, read a paper entitled, "Brick Paving for Carriageways" (vol. xxiii. p. 397). In December, 1897, one of the large makers of blue bricks in this town offered 25,000 paving bricks to the Corporation for the purpose of experimenting as to their suitability for a carriageway; several other firms also offered a quantity of special and ordinary bricks for the same purpose. The offers were accepted by the Council, and the Author, under instructions of the Highway Committee, commenced in May, 1899, to lay them down in Spon Lane on the side of the tramway; this road was chosen on account of its heavy traffic; the quantity of bricks laid was 25,000 (9 inch by 4½ inch by 3 inch) special made, and 2000 (9 inch by 5 inch by 2½ inch) special made, and 3000 (9 inch by 4½ inch by 3 inch) ordinary best blue stocks, making a total of 30,000. The first and second bricks were made with rounded nosings, the others square. In the opinion of the Author, the bricks should be 2½ inches wide.

The foundation consisted of 6 inches of Portland cement concrete, 6 to 1. The bricks were laid on a 2-inch sand cushion in straight courses at right angles to the kerb, the bricks being laid right up to the kerb without any channel courses; they were laid solid end to end and side by side, without leaving any interstices. When the bricks were laid, and before any grouting was done, the paving was well rammed with hand rammers, a board being used for this purpose; all defective bricks were removed. Portions of the work were then grouted with cement and sand in the proportions of 3 to 1, and other portions were grouted with pitch: in this case the pitch was poured through a funnel, so as not to run all over the bricks.

The whole of the paving was kept fenced in for one week,

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covered with ½ inch of sand, and opened for traffic on June 17, 1899.

The cost of the work, exclusive of bricks, was as follows:—

—	Cost.			Cost per square yard.	
	£	s.	d.	s.	d.
Excavation of macadam, etc.	8	8	0	0	4·26
Concrete foundation	58	0	6	2	5·44
Labour, laying, paving	10	16	8	0	5·50
Labour, resetting kerbs and making good to the work	4	0	3	0	2·03
Pitching, labour and materials	11	4	4	0	5·69
Hauling bricks, excavated material and other materials	15	3	11	0	7·71
Watching and sundry items	6	0	3	0	3·05
	113	13	11	4	9·68

The length of paving laid down is 167 lin. yards and width 8 feet 6 inches; the total area being 473 square yards; this gives a cost of about 4*s.* 10*d.* per square yard for the work, exclusive of the bricks.

A further area of 178 square yards of paving was laid down in August, 1899, consisting of best rounded edge blue bricks and part of common blue bricks, at a cost of 34*l.* 10*s.* 4*d.*, or about 4*s.* per square yard.

Records of the traffic passing over this portion of the roadway have been carefully taken between the hours of 6 a.m. and 8 p.m. on the following dates:—

1899	October	2nd to 7th inclusive
1899	December	4th to 9th „
1900	April	2nd to 7th „
1900	August	13th to 18th „

A summary of these returns is given in the Appendix, and it will be seen that the traffic passing over the paving, and which can be taken as a fair average, is not of a light character, but that the bricks have had a severe test.

Blue brick paving affords a good foothold for horses, and is clean, but in the opinion of the Author, the bricks are not at present made suitable for roads of very heavy traffic, and the cost, as compared with granite sett paving, is against its adoption in large quantities.

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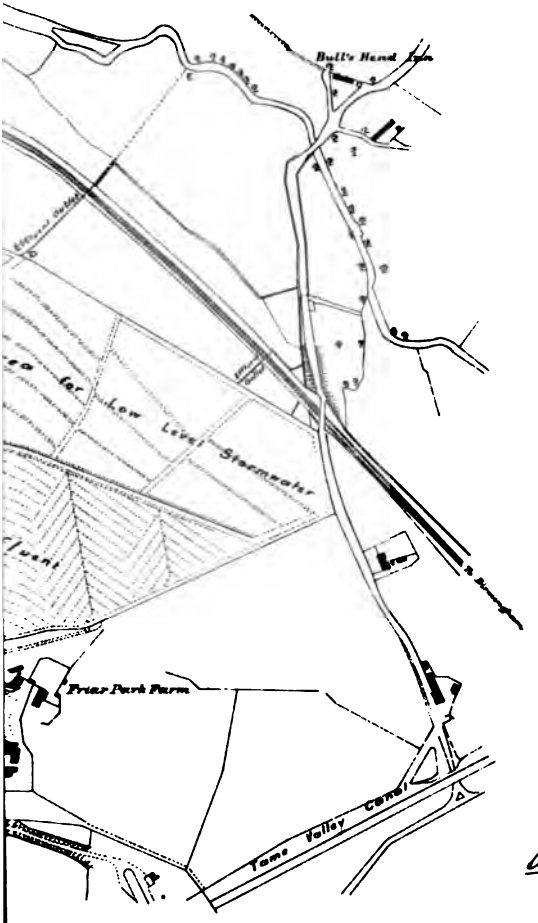
ɔF WEST BROMWICH Nº 1

ʌCE. FRIAR PARK.

Nº 1.



Albert S. Gradidge
Surveyor, Cert. Inst. C.E.
Borough Engineer
Nov. 1900.

"PHOTO-LITHO." R. J. EVERETT & SONS, 56, LUDGATE HILL, LONDON.

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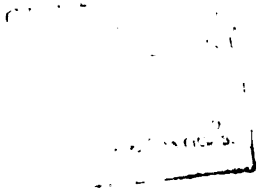

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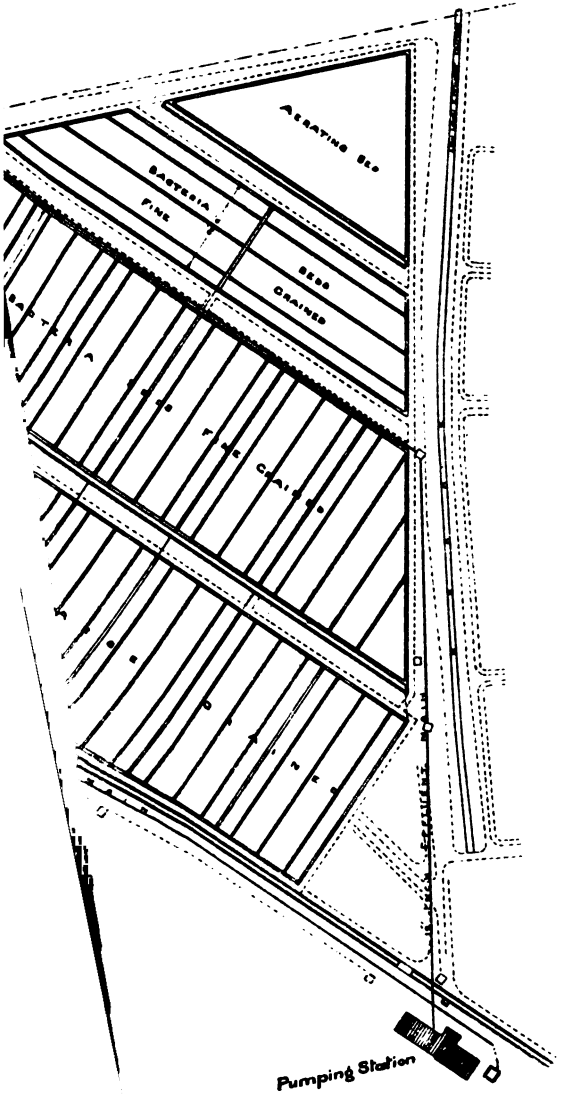
DRAWINC Nº 2



Albert S. Gresley
Assoc. M. Inst. C.E.
Borough Engineer.
March 31. 1902.

"PHOTO-LITHO." R. J. EVERETT & SONS, 56. LUDGATE HILL, LONDON.

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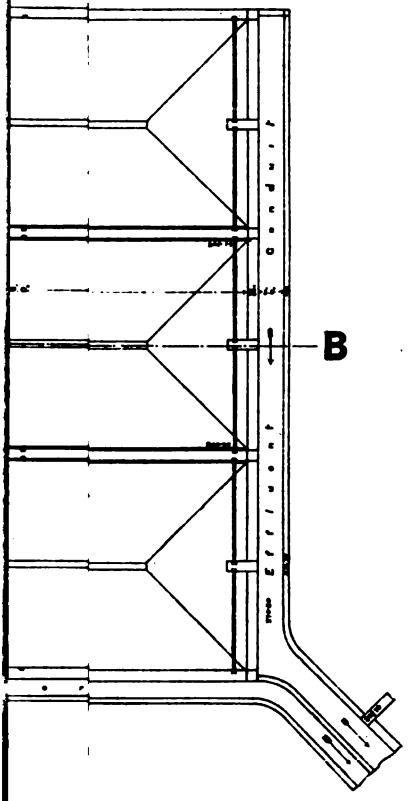
ROCH

DRAWING Nº 3.

OSBW LEVEL



Alfred B. Reading
Assoc. M. Inst. C.E.
Borough Engineer.
Lowestoft, 1900.

"PHOTO-LITHO." R. J. EVERETT & SONS, 66, LUDGATE HILL, LONDON.

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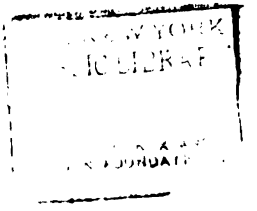

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ROMWICH

DRAWINC Nº 4

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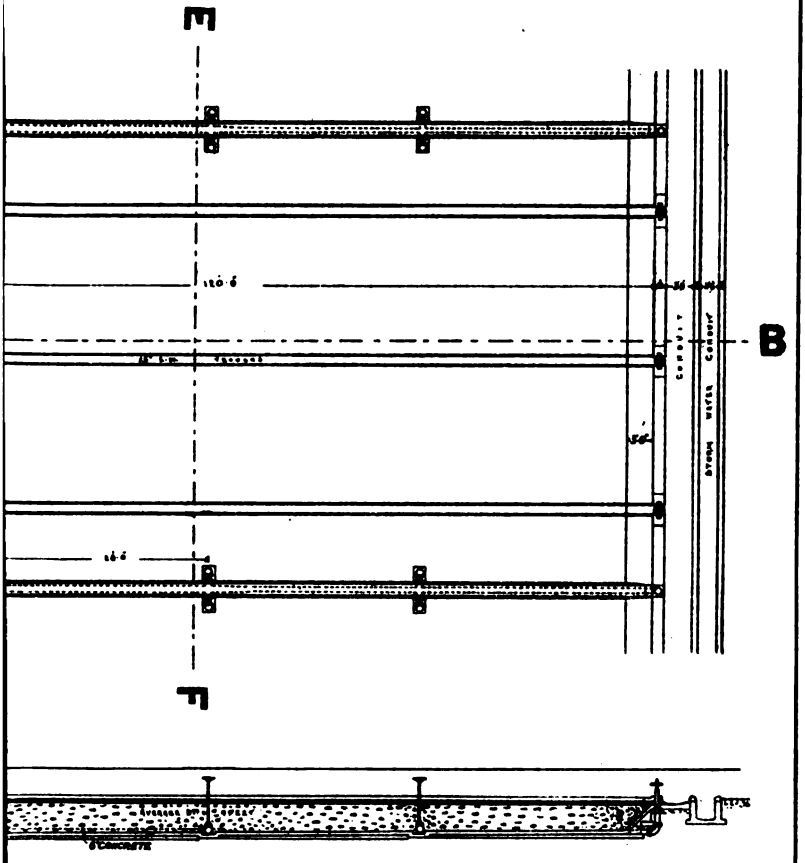

SECTION E F.

Albert B. Preedy
Assoc. M. Inst. C.E.
Borough Engineer.
March 31. 1902.

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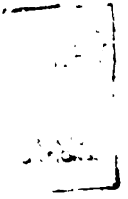

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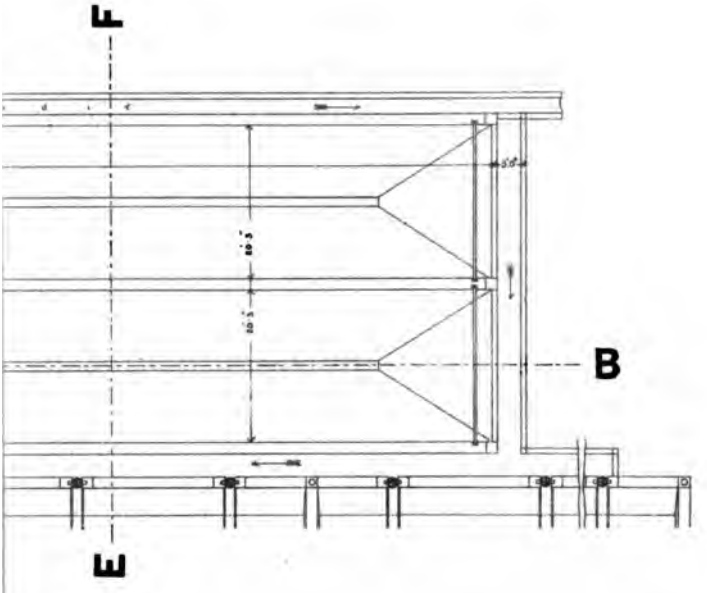

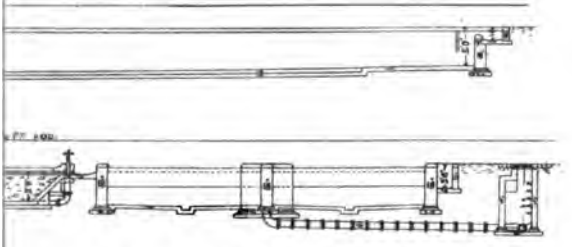

SECTION EF.

Albert B. Greatorex
Assoc. M. Inst. C.E.
Borough Engineer.
March 31st 1902.

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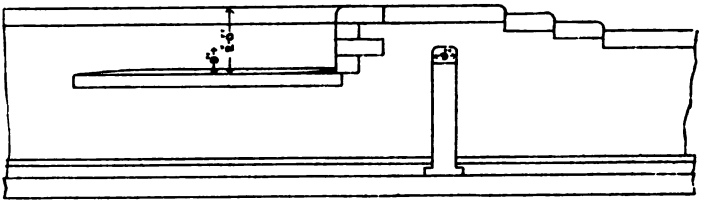

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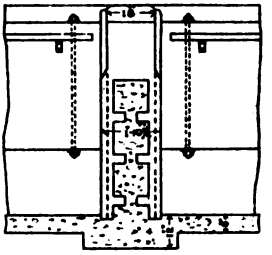

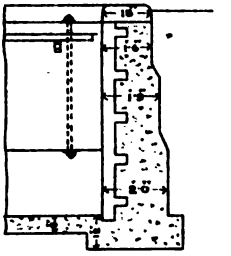

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SECTION OF TRANVERSE DIVISION WALL

SECTION OF EXTERNAL WALL

Walter Gilbert
Asst. C.E. & A.M.I.C.E.
Borough Engineer's Office
March 1902.

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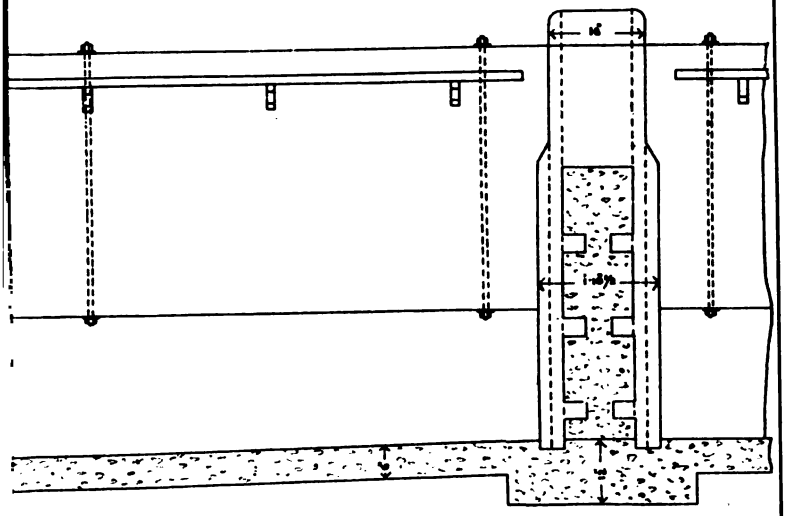
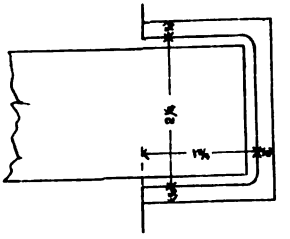
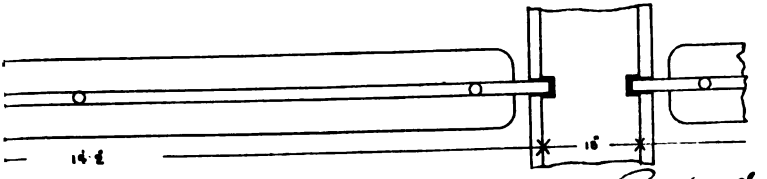




IM-BOARD.

PLAN OF CHANNEL IRON
FULL SIZE



Borough Engineer.
Oct. 1900.

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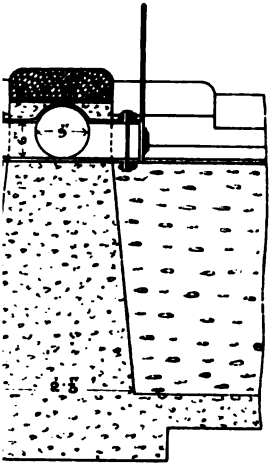

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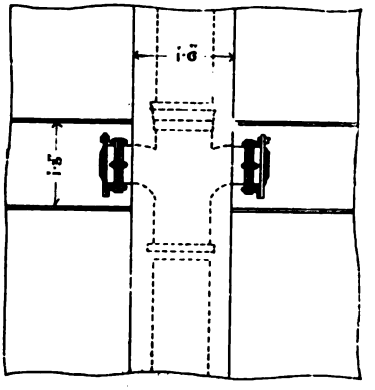

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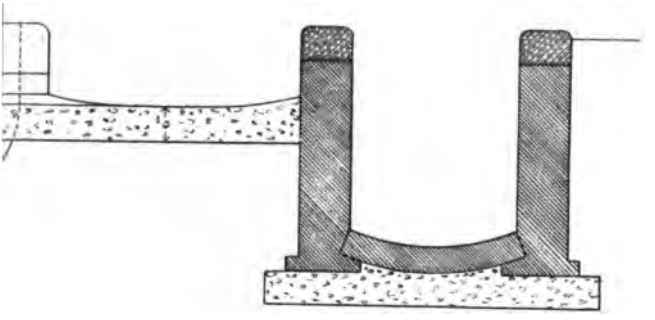

SHEWING VENTILATION
EFFLUENT DRAIN

Alfred Greatorex
Assoc. M. Inst. C.E.
Borough Engineer.
March 31. 1900

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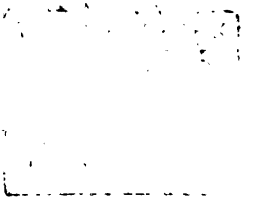

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RAIL, JOINTS

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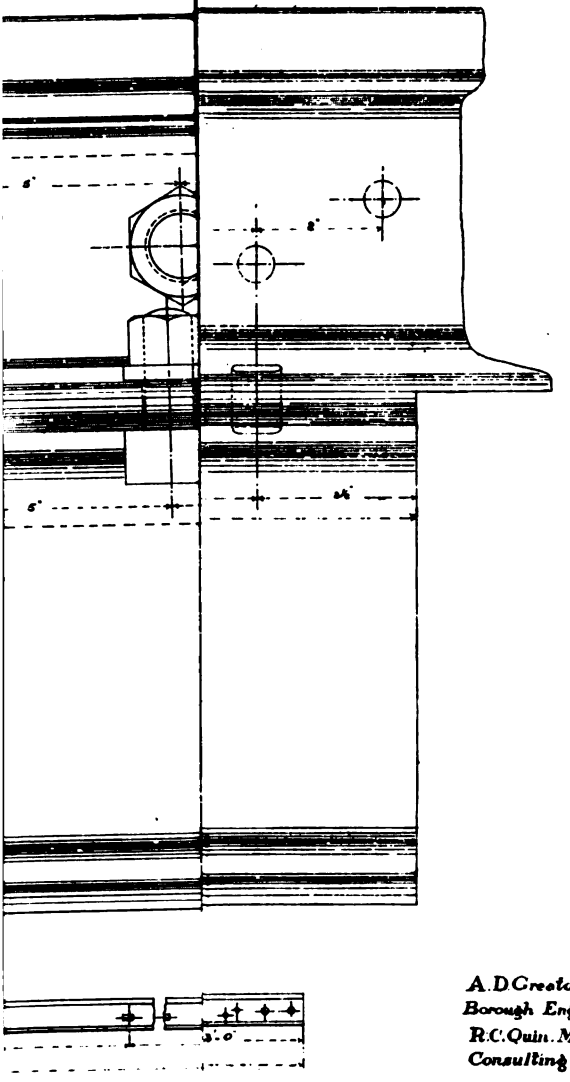

A.D.Crestorex A.M.I.C.E.
Borough Engineer and Surveyor.
R.C.Quin. M.I.E.E. M.I.M.E.
Consulting Electrical Engineer.

"PHOTO-LITHO." R. J. EVERETT & SONS, 56, LUDGATE HILL, LONDON.

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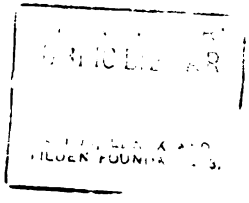

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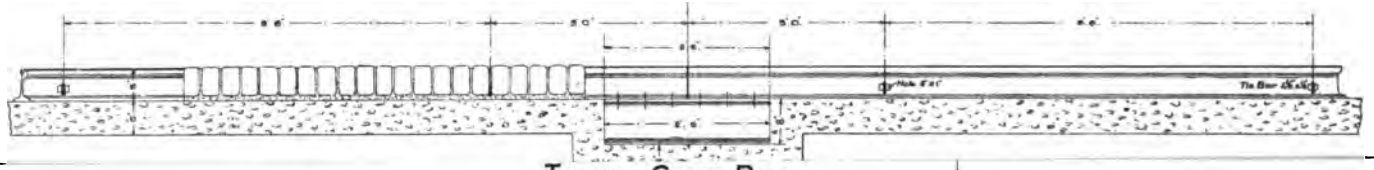
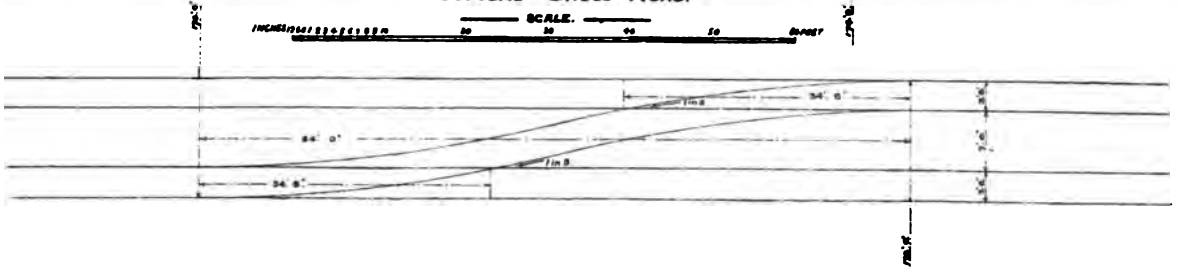
COUNTY BOROUGH OF WEST BROMWICH

CROSS SECTION.



TYPICAL CROSS ROAD.

SCALE.



Albert D. Crealock A.M.I.C.E.
Borough Engineer.
Robert C. Quin M.I.E.E. M.I.M.E.
Consulting Engineer.

"PHOTO-LITHO." R. J. EVERETT & SONS, 58, LUDGATE HILL, LONDON.

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ROMWICH

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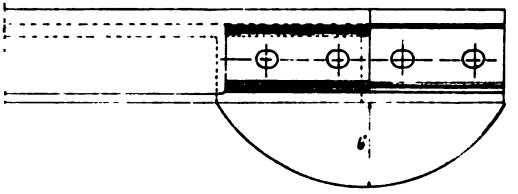

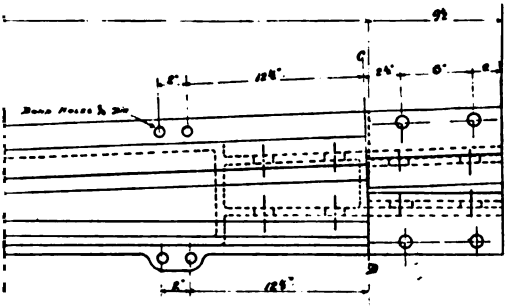

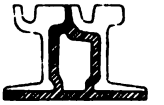

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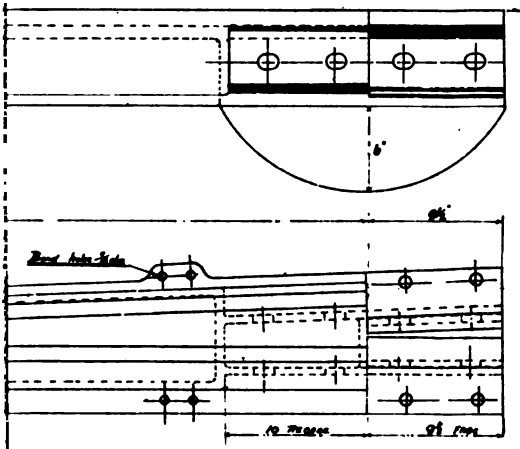

A.D.Greatorex. A.M.I.C.E.
Borough Engineer and Surveyor.
R.C.Quin. M.I.E.E. M.I.M.E.
Consulting Electrical Engineer.

"PHOTO-LITHO." R. J. EVERETT & SONS. 66, LUDGATE HILL, LONDON.

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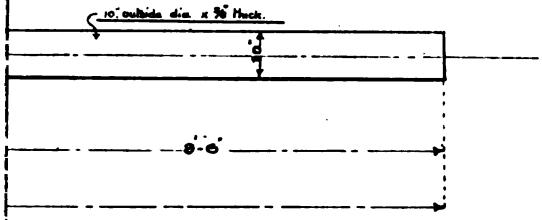
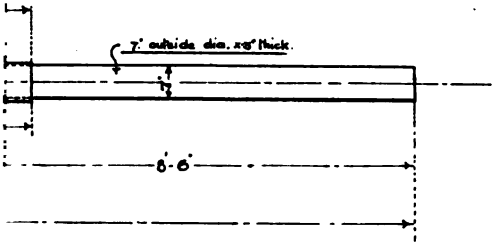
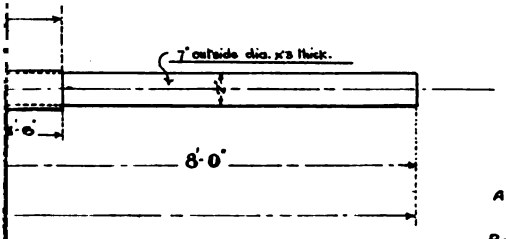
BROMWICH No 14







Albert D. Greatorex A.M.I.C.E
Borough Engineer
Robert C. Quin M.I.E.E. M.I.M.I
Consulting Engineer.

TO-LITHO." R. J. EVERETT & SONS, 56. LUDGATE HILL, LONDON.

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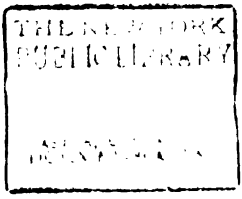

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EST BROMWICH —— Nº 15

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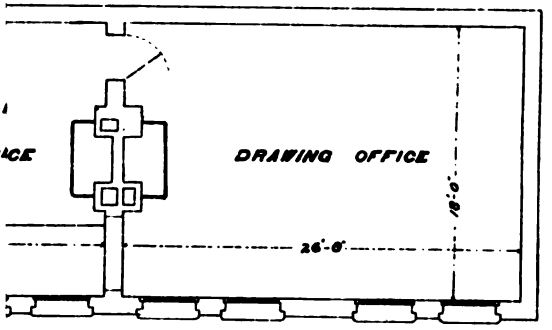

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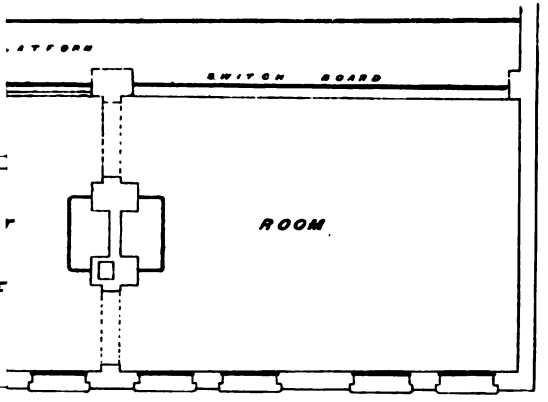

Albert Gresty
Assoc. M. Inst. C.E.
Borough Engineer.
February 1900.

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"PHOTO-LITHO." R. J. EVERETT & SONS, 56, LUDGATE HILL, LONDON.

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BOROUGH OF WEST BROMWICH. RECORD TABLE OF STREET TRAFFIC.

Date.	Hour.	Description of Vehicles.														
		Heavy Dray 90 cwts.	Light Dray 40 cwts.	Heavy Van 70 cwts.	Light Van 35 cwts.	Tradesmen's Shop Vans 2-wheel 15 cwts.	Tradesmen's Shop Vans 4-wheel 25 cwts.	Carriages and Cabs 15 cwts.	Loaded Carts 40 cwts.	Empty Carts 18 cwts.	Traps 12 cwts.	No. of Horses.	Exceptional Loads weight to be inserted.			
													tons.	cwts.	qrs.	lbs.
1899 October 2	6 a.m. to 8 p.m.	8	6	8	16	5	36	20	17	42	76	265	23	10	0	0
„ 3	„	22	4	9	17	15	24	19	17	45	81	302	116	0	2	16
„ 4	„	23	1	12	18	24	35	9	21	42	90	330	156	8	3	0
„ 5	„	10	9	11	12	17	50	12	24	29	100	312	140	6	2	0
„ 6	„	3	..	12	17	15	47	18	34	66	80	314	99	18	1	20
„ 7	„	8	..	7	13	22	41	9	26	54	80	289	83	3	0	0
Total for the Week	..	74	20	59	93	98	233	87	139	278	507	1812	619	7	1	8
1899 December 4	6 a.m. to 8 p.m.	2	15	20	23	3	25	16	8	62	58	266	..	..	..	..
„ 5	„	1	11	20	25	18	32	31	20	59	65	296	5	1	0	0
„ 6	„	15	11	10	40	9	37	20	43	80	55	365	5	12	0	0
„ 7	„	13	16	18	13	13	30	8	38	77	35	313	12	7	3	0
„ 8	„	2	19	13	26	18	43	19	23	49	37	251	28	15	2	0
„ 9	„	2	5	9	15	11	41	13	21	52	50	245	11	13	3	0
Total for the Week	..	35	77	90	142	72	208	107	153	379	300	1736	63	10	0	0

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Borough of West Bromwich. Record Table of Street Traffic.

Date.	Hour.	Description of Vehicles.											
		Heavy Dray 90 cwts.	Light Dray 40 cwts.	Heavy Van 70 cwts.	Light Van 35 cwts.	Tradesmen's Shop Vans 2-wheel 15 cwts.	Tradesmen's Shop Vans 4 wheel 25 cwts.	Carriages and Cabs 15 cwts.	Loaded Carts 40 cwts.	Empty Carts 18 cwts.	Traps 12 cwt.	No. of Horses.	Exceptional Loads weight to be inserted.
1900.													tons. cwts. qrs. lbs.
April 2	6a.m. to 8p.m.	5	8	16	22	3	25	31	26	78	58	308	..
„ 3	„	2	12	17	21	4	28	21	17	62	66	292	..
„ 4	„	3	5	16	36	5	33	28	18	67	46	283	..
„ 5	„	6	12	14	38	22	43	18	23	49	58	310	..
„ 6	„	2	13	21	22	11	49	20	25	63	79	343	23 11 2 0
„ 7	„	1	9	13	21	11	42	25	12	48	65	286	..
Total for the week	..	19	59	97	155	56	220	143	121	367	372	1,822	23 11 2 0
1900.													
August 13	6a.m. to 8p.m.	23	63	..	5	34	24	16	32	35	57	342	..
„ 14	„	33	65	..	6	24	15	8	62	49	72	353	..
„ 15	„	41	54	3	15	22	9	13	53	38	54	328	..
„ 16	„	37	64	1	11	18	6	6	50	48	50	316	..
„ 17	„	42	77	2	10	22	11	21	47	36	54	373	..
„ 18	„	30	68	2	5	23	9	21	46	28	63	323	..
Total for the week	..	206	391	8	52	143	74	85	290	234	350	2,035	..

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The particulars given in the preceding Tables are briefly summarised as follows:—

Date.	Total weight.	Average weight per day of 14 hours.	Average weight per day of 14 hours per yard width of paving.	Average weight per annum per yard width of paving (300 days of 14 hours).
1899	tons.	tons.	tons.	tons.
October 2 to 7 ..	2,664	444	156·9	47,070
December 4 to 9 ..	2,160	360	127·2	38,160
1900				
April 2 to 7	2,057	343	121·2	36,360
August 13 to 18 ..	3,092	515	182	54,600
Average ..	2,493	415	146·8	44,047

Architectural Works.

Description of Alteration and Enlargement of Public Baths.—The Public Baths have undergone a considerable alteration and enlargement. The old Superintendent's house and the whole of the original front elevation have been pulled down, including the first and second class ladies' slipper baths, etc., and the new front has been brought to the street line. The first class swimming bath has been entirely remodelled, being now 28 feet longer—the bath itself 25 feet longer, which has made it 75 feet by 30 feet. The bath has been relined with best white glazed bricks; the roof has been taken off and the building raised 6 feet; part of the old roof is refixed, with a new match-boarded ceiling in place of the old plastered one. The old lantern, which was decayed, has been replaced with a new one, with more light and ventilation, and the sides of the lantern, the whole length, are made to open, and the roof has been covered with patent glazing. The old dressing boxes have been repaired and improved, and a gallery put all round the bath over the boxes 6 feet wide, carried on cast-iron columns and brackets, with cast-iron balustered railing and oak hand-rail. Two staircases are provided, and special exits for use at gala and swimming sports. The walls of the swimming bath are plastered and coloured in distemper. A dressing-room has

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been provided at the corner of Lombard Street West and Edward Street for use by the Swimming Club. The lavatory accommodation has been removed and placed on side of bath, fronting Edward Street. The entrances and pay-office occupy the space where the old house stood; there is an entrance for women and one for men, with a pay-office in the middle; these are all lighted by a lantern light. Waiting-rooms are provided at each entrance. The second class swimming bath has been considerably improved. All the glazed lining to the bath, which was worn badly, has been cut out and new white glazed bricks inserted. The ceiling, which was plastered, has been boarded and painted. The old lantern, which was decayed, has been replaced with a new one, similar to the first class swimming bath; new lavatory accommodation is provided at the rear. The walls round the bath have been match-boarded above seats and painted, and the walls above coloured. New ladies' slipper baths are provided in front of the second class swimming bath and fronting Lombard Street West, namely, three for first class and three for second class, each 9 feet by 8 feet. These baths are lighted with a lantern, similar to the swimming baths; the walls are plastered in adamant and coloured. The divisions of the baths are made of pitch-pine framing, stained and varnished. At the side of the slipper baths dressing-boxes are provided, which can either be used by the men or the women when using the second class bath.

The materials used for the front elevation are King's best red and buff facing bricks and best Hollington stone dressings.

An Engineer's house has been provided at the rear of the baths, and consists of parlour, living room and scullery, with three bedrooms.

The contract for the building was let to Messrs. R. and E. Woodward, of West Bromwich, and was executed in a good and substantial manner at a cost of 4232*l.* 11*s.* 4*d.*

New Police Buildings and Reading Room, Hill Top.

These buildings have been erected to fill a long-felt want in the Hill Top district.

It was originally the Council's idea to convert an old family mansion, known as Meyrick House, into public buildings, but owing to its being in such a dilapidated condition through

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mining operations, and the cost of converting it so much more than anticipated, the Council unanimously decided, on the recommendation of the Author, to pull down the old house and erect new buildings.

The accommodation required in the new buildings was: a public reading room and house for the park keeper (who was also to act as caretaker to reading room), police premises with charge office, two cells, sergeant's house, and accommodation for four single constables. A branch fire station was also to be provided.

The new buildings, which are partly Classic in style and stand on an elevated and attractive site, have been designed principally in three separate blocks grouped together symmetrically in one. The reading room and sergeant's house are at each end of the building, with two main entrances in centre, one for reading room and caretaker and the other for police premises; the entrance to the sergeant's house being on the side. The reading room entrance has an attractive portico with seats for the use of the public. The centre feature of elevation is designed with a gable, and has a clock in the centre which was subscribed for by the public.

No. 1 Block consists of reading room, 26 feet by 22 feet 6 inches, and magazine room opposite, 14 feet 6 inches by 13 feet, with lavatory accommodation. The reading room is heated with hot water on the low pressure system. At the rear is accommodation for a caretaker and park keeper, and consists of living room, scullery with yard and necessary outbuildings, and three good bedrooms on the first floor facing main road.

No. 2 Block consists of charge office, 18 feet 9 inches by 16 feet, two cells, 13 feet by 7 feet, prisoner's yard and lavatory accommodation. In connection with the Block, on the first floor is accommodation for four single constables overlooking the park, and consists of living room, bedroom, bathroom with separate lockers, and clothes room.

No. 3 Block consists of sergeant's house (which is connected to charge office), and includes parlour, living room, scullery with pantry, yard and outbuildings at rear, and three large bedrooms on first floor facing the main road. At the rear and adjoining sergeant's house yard is a fire engine house, 15 feet by 13 feet, and tool house, 13 feet by 10 feet 9 inches. There are also three latrines for men and three for women in connection with the park at the rear of the prisoners' yard.

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The materials used in the front elevation are King's best facing bricks and best fine Hollington stone dressings. English oak framing is used in gables and centre feature above first floor, with solid oak cornices and copings; all the other elevations are faced with best local facings. The whole of the roofs are covered with Lewis's best red tiles.

The contract for the buildings was let to Messrs. Henry Smith and Son, of West Bromwich, and was carried out at a cost of 3,478*l.* 18*s.* 2*d.* Both these buildings have been erected from plans and under the superintendence of the Author, ably assisted by Mr. F. Woodward (Surveyor of Stourbridge), at that time architectural assistant.

Besides the above mentioned architectural and other works carried out during the past five years, the following smaller buildings, etc., have been executed from plans and under the supervision of the Author:—

	£
Additions to technical institute	1,380
Additions to administration block and lodge at hospital ..	731
Laying out two parks from plans prepared by Mr. J. T. Eayrs	3,500
Two bandstands	400
Reading room and lodge, etc., Kenrick Park (in course of erection)	1,031
Extension of sewers	1,600
	£8,642

There are various other smaller works, besides the preparation of plans and details for the conversion of the free library into additional office accommodation, and the conversion of the market hall into a free library, for which a provisional order has been obtained. The estimated cost of this work was 6,500*l.*, exclusive of furniture and fittings, but for many reasons it has been postponed for the present.

The Author desires to place upon record the assistance so ably rendered him at all times by Mr. D. Ellison, the Assistant Borough Surveyor, and every member of his staff.

The Secretary then read the following communication on the paper which had been received from Mr. R. C. Quin, Consulting Electrical Engineer, who was unable to attend the meeting.

Mr. Greatorex has very fully treated the subject of electric

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lighting and tramways, and there remains very little for me to add. It will be noticed that the whole of the machinery installed at the generating station is capable of being used either for traction or lighting. There is therefore considerable economy in stand-by plant. The system of house purchase wiring is, I believe, new and it certainly is successful, as the Table on page 57 shows. It ensures to the consumer sound work, with good materials, at a fair price. There are several points in connection with the tramway construction which vary from standard practice. In the first place, no expansion is allowed for in the rails. The joints are made by girders bolted to the bottom flange of the rails, and embedded in concrete, as well as the usual fish-plate joint. Now, the coefficient of linear expansion of steel is approximately ·0000066. If then we allow for a variation of temperature of 50° Fahr. in either direction the free contraction and expansion would be ·00033 of its length, which is equivalent to 11,990 lbs. per square inch, tension or compression. This gives us a safety factor of certainly not less than three of the elastic limit of steel. If, therefore, we anchor the rails with anchors of sufficient strength to withstand these stresses, it is obvious that the action arising from variation of temperature will consist solely of a safe molecular action, well within its elastic limits. Further, it must be borne in mind that open joints left for expansion mean hammering of car-wheels, and there is nothing more certain in tramway practice than that the life of the rails is limited by the life of the joints. The only conclusion to come to is that facilities for expansion of rails are uncalled for, and that it is both detrimental to the life of the rails and rolling stock. While I have endeavoured to prove that the expansion of tramway rails due to temperature variation is negligible, I have on the other hand to point out that this temperature variation is a very important factor in connection with the overhead line, and the consequent stresses upon the supporting poles. If we take a single span of 40 yards of trolley wire of 000 gauge, erected when the temperature of the atmosphere was 60° Fahr., and allow a sag of nearly 19 inches, we have a stress upon the supporting poles of about 400 lbs. If this wire be not used, and therefore neither stretched nor worn by the trolley wheels, and the temperature of the atmosphere fell to 20° Fahr., the tension on the trolley line and its supports would immediately rise to 2000 lbs., the sag being

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reduced to rather less than 4 inches. To my mind nothing looks worse and does more harm to the industry than an overhead system erected with slack wires and bent poles. On the other hand the system should be constructed with due regard to the stresses to be borne. It is perfectly obvious that we must look to a maximum stress of not less than 2000 lbs. on the trolley wire, and it does not need a great amount of engineering skill to find the stresses upon poles, more particularly on curves. The diagram attached to these notes shows within the limits of 20° to 90° Fahr. the variation of sag and tension on a 40 yards' span of this trolley wire. The question which I should like you to consider is how many inches you would permit your poles to be bent from the straight line under normal conditions before you considered the poles an eyesore, and I would also ask you not to confuse in your minds the usual specification for poles, in which a certain number of pounds tension is to give something like 5 or 6 inches deflection. It is of course advisable to test your poles well up to their elastic limit, but you have to consider an entirely different set of figures for normal stresses than these test figures. Supporting poles should not under normal conditions of stress vary so much from the straight line as to be noticeable to the casual eye.

DISCUSSION.

Mr. J. PRICE: I beg to propose a hearty vote of thanks to Mr. Greatorex for his very valuable and instructive paper. I notice a reference in the paper to the fact that manufacturers' liquid refuse, or rather the acid portion of it, is not allowed to discharge into the sewers. In my opinion it is policy on the part of a corporation to assist the trader, but the trader, on his part, must also assist the corporation in dealing with his refuse, and must not send neat, or nearly neat, acid into the sewers. I have no doubt Mr. Greatorex will tell us what means of inspection—it all depends upon inspection—he has to prevent this acid waste entering the sewers. What means have been taken for determining the storm-overflow? is it taken as six times the water supply, or is it the so-called dry-weather flow of the sewage? I see, with respect to the

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DIAGRAM SHOWING SAG AND TENSION IN 120-FT. SPAN OF TROLLEY WIRE (3/0 gauge).

Sag — · — · —

Tension .....

[*To face p.* 72.

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municipal supply of electricity, that the charges are extremely low, and that the Corporation have met with a loss. I can quite understand, with the introduction of a new system of lighting like this, you must encourage the public to take the electric light to begin with, even if you have to raise the price afterwards to make it pay. If you do charge too low a price, a certain number of ratepayers are receiving a subsidy at the expense of the general body of ratepayers. Passing to the tramways, I notice a departure from recent practice. The depth of the rail used is given as 6 inches. I should like to know why that depth of rail has been selected, because if you take the relative strength as between a rail of 6 inches and one of 7 inches, it is as 216 to 343. I have not adopted the system of testing the rails which is current here. When you specify for a rail with ·60 of carbon, you get a rail extremely brittle. It is very hard, and will stand wear very well; but if you drop it from a lorry to the ground you must not be surprised if it breaks in two. Therefore, I have not thought it advisable to make any drop test in any rails I have used.

Mr. J. T. Eayrs: I rise with pleasure to second the vote of thanks. There are one or two items which Mr. Greatorex has not given you. The population of West Bromwich at the present time is 65,000, and the area about 5700 acres. The approximate length of sewers is 60 miles. At the present time the low-level outfall sewer—about 3 feet in diameter—in which there is probably a dip of 4 feet or 5 feet caused by mining subsidence, has caused no trouble or inconvenience to the flow of the sewage, nor has it been cleaned out to my knowledge since it was laid some eighteen years ago. With regard to the high-level sewer, I should like to mention that it is constructed as a hydraulic main. The length is over 2000 yards, and it has a fall of 1 in 310. There are several depressions in it—the greatest depression between the outfall and the lowest point is 35 feet. On this main there is only one air valve. The main is 24 inches in diameter, and serves a population of 28,000 or 29,000. This main has never been cleaned, and it has always acted satisfactorily as an inverted syphon. That saved the Corporation the expense of pumping, which meant a considerable item in annual charges. The main is much too large for the present population, and therefore the velocity is very much reduced. The result of this

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is that septic action is set up in the main, and, as you will probably see, at the outfall the sewage is in a septic condition when it reaches the farm. The discharge of manufacturers' refuse into the sewers is a most important point in a district like this. In West Bromwich, strong efforts were made by manufacturers to secure a connection with the sewers, but the Corporation stood very firm on the point, and would not allow them to be made. Although facilities should be given to manufacturers, it should be with such restrictions that there would be no fear of damage to the sewers. In West Bromwich there are a great many iron sewers. The effect of pouring in salts of iron and muriatic or sulphuric acid from galvanizing works, would be quite destructive to iron pipes, as well as to cement and lime.

Mr. J. LEMON: I think the Corporation of West Bromwich made a mistake when they reduced the price of the electric light from 6*d.* to 4½*d.* per unit, because the effect of it was to throw a deficit upon the rates. I think all municipal undertakings should be carried out on commercial lines only. You should charge a fair price, and 6*d.* per unit is a very fair price indeed. I must congratulate the Corporation upon the great step they have taken in getting a loan of 10,000*l.*, and fitting up the houses with the electric light. That has been a means of getting the electric light introduced into houses where it otherwise would not be. I should like to say a word about the discharge of acids into the sewers. Happily in the South of England we are not troubled with that difficulty. I think it is wrong in principle to discharge acids into the sewers, and I hope the Corporation will stand firm and keep them out. That is being done in the Mersey and Irwell watershed, and it ought to be done in West Bromwich. It is not fair to the ratepayers, who have to maintain the sewers in a high state of efficiency, to have these acids turned into the sewers. The traders ought to treat their own waste liquor; they can do it; and they ought to do it for themselves.

The PRESIDENT: I should like Mr. Greatorex to give us the rateable value of the borough, and the area of the bacteria beds at the sewage works. As far as I can make out from the figures given in the paper, the beds work out at something under 5 acres.

Mr. A. J. DICKINSON: What percentage of capacity is lost

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by the filling up of the bacteria beds? I should also like to know if you find where you put the purified effluent on the land, that it affects the cropping capacity?

Mr. GREATOREX: The figures are given in the paper. It is, on the average, about 43 per cent. The original capacity of the low-level coarse bed on October 3, 1899, was 52,500 gallons, and on October 29, 1900, 29,455 gallons, a loss of 43·90 per cent. In the paper, I attribute the high percentage of loss to passing the raw sewage into the bed. I have had no detritus tanks at work. As to cropping capacity, no. You still have the value of the sewage in the effluent as a manurial agent.

Mr. A. H. CAMPBELL: Where do you take the temperature of the bed?

Mr. GREATOREX: At the bottom of the bed. An earthenware pipe is fitted in the beds, and the man drops the instrument to the bottom. We have not had the slightest difficulty in the coldest weather with the beds.

Mr. A. H. CAMPBELL: What are the estimated working expenses of the scheme?

Mr. GREATOREX: The working expenses of this scheme, capable of treating 1,200,000 gallons a day, will be two men, costing 130*l.* a year. I contend we need not put our effluent on the land at all. Therefore, 130*l.* a year is the working expense. I estimate that to treat the sewage by chemical precipitation would cost about 1500*l.* a year in working expenses, so we repay the whole of the capital cost by the saving in working expenses.

Mr. T. R. SMITH: As to the septic tank, I suppose you expect to get a scum to cover the top of the septic tank. In times gone by one has heard a good deal about the value of having a scum form on these tanks. When at Manchester the other week, I visited the works there, and I found there was no scum on the septic tanks. I asked about it, and was told that from time to time a scum had formed, but was broken up by the weather. I afterwards put a question to Mr. Fowler, the chemist, but he did not seem to attach any great value to the forming of a scum. I notice that Mr. Greatorex says that the sewage is rather dilute. As the population of West Bromwich is 65,000, it works out at 20 gallons per head per day, which would not be a dilute sewage.

Mr. G. W. LACEY: I have just been collecting and tabulating

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some information as to the septic and bacteria process carried on in various towns, and one cannot help being struck by the difficulties which all have met with from the sludging up and decreased capacity of the primary beds. The general opinion of engineers is that a hard refractory material is the best for filling the primary beds. My own beds are filled with cinders, and we have been in a difficulty owing to their decreased capacity. I take it that what Mr. Greatorex has referred to as ashes is a clinker, and I should say that would hardly have the same tendency to break down as a cinder.

Mr. GREATOREX: It is a clinker from the gasworks. The material has been thoroughly tested and analysed. It has been tested with the sewage in a small experimental tank, and it has been tested in the laboratory by the constant dropping of water on it for three months to see if it breaks up. It has stood both tests well.

Mr. J. S. PICKERING: There is one matter Mr. Greatorex has not been so thorough in, that is in his experiments on the capacities of the beds. He appears to have left off the experiments just when they were becoming most interesting. I notice Mr. Greatorex proposes to put down an area of about 3 acres of coarse bacteria beds, and that his dry-weather flow is something like 1,200,000 gallons per day. He proposes, in addition, to treat an equal volume of storm water on the beds, bringing up the total quantity to be treated on the coarse beds to 2,400,000 gallons a day. I am extremely doubtful as to the results. I do not think it possible to treat this quantity of sewage and storm-water on 3 acres of beds. On the low level there is a total area of coarse and fine beds of 14,400 yards, which is said to be capable of treating 1,600,000 gallons, and on the high level, 6,000 square yards of coarse beds, stated to be capable of treating 1,440,000 gallons. I think this is a little misleading, as these figures give the liquid capacity of the beds when new, and which is only their treating capacity for a very short time. The experiments conducted by Mr. Greatorex prove that these figures could not be calculated upon as the working capacity of the beds. The reduction of 43·77 per cent. in capacity in the coarse beds, shown in the paper, would mean that the original capacity has been reduced to about half a million gallons per acre per twenty-four hours after eighteen months' working, assuming the beds to be charged three times a day. I am sorry Mr.

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Greatorex has not carried the experiments further, and shown the capacities of the beds for a further twelve months. I think the silting up is gradually increasing. No one has brought figures to prove the statement, although it has often been made, that there is a period in the life of the beds when the silting up actually ceases. Those who have the management of bacteria beds will have to recognise the necessity which will arise sooner or later of renewing or sifting the material of which the beds are composed. I do not think that it is a serious disadvantage, because the working expenses are so much less than in other systems that one can afford to put by a sum of money to meet the contingency. In my own case the adoption of the bacterial process of purification has resulted in a saving of about 2,000*l.* per annum in working expenses over the old chemical treatment, and I have recommended that 100*l.* per annum should be put aside so that in a few years we shall be able to use the reserve fund in resifting or replacing the material as may be necessary, and there will not be in any one year a heavy burden on the rates. I should like to ask Mr. Greatorex how he proposes to deal with the sludge after intercepting it in his tanks. The sludge becomes a very great nuisance, and if not properly dealt with it is a question which requires very careful thinking out.

Mr. J. LEMON: I think Mr. Pickering has lost sight of one important matter in the figures he has quoted. With the experimental beds there was no sedimentation at all; but now Mr. Greatorex has provided these tanks it will have the effect of preventing the silting up of the primary beds. That is a matter which has been overlooked. Some Town Councils appear to have got it into their heads that the bacteria will eat up minerals and everything and anything in the sewage. The key of the problem is to provide a sufficient area for sedimentation. I carried out some experiments with beds I constructed, but I could not get the Council to put in detritus tanks, with the result that the beds silted up. I am glad to say they are now going to put them in, and that will prevent the filling up of the beds. It stands to reason if you send down in the sewage a lot of mineral matter it must tend to fill up the beds. I believe Mr. Greatorex has made ample provision for sedimentation in providing for half-a-day's flow, but if it should be necessary to increase that, it will not be necessary to interfere with the scheme, which is complete in itself and capable of extension.

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Mr. GREATOREX: Mr. Pickering has misread the paper. The bacteria beds are designed to treat twice the dry-weather flow. We do not treat the storm water on these beds. That is separately treated.

Mr. PICKERING: But you take three million gallons on these beds?

Mr. GREATOREX: No; twice 800,000 gallons.

The Members having visited the New School of Art and the Baths, were entertained to luncheon by the Mayor (Councillor J. H. Chesshire) at the Town Hall. The afternoon was devoted to visits to the electric light works and the sewerage works, where the existing bacteria beds in operation and the new beds in course of construction were inspected with much interest. The discussion upon Mr. Greatorex's paper was completed after the inspection of the works. Upon returning to West Bromwich the Members were entertained by Mrs. Greatorex to "afternoon tea."

COMMUNICATED DISCUSSION.

Mr. LEMON: As to the hydraulic main. This is stated to be 24 inches in diameter, with a small velocity, and that it is working satisfactorily; on the other hand it is stated that it acts as a septic tank.

I have no doubt myself that it is slowly silting up. These hydraulic mains are under different conditions to a pumping main, which is constantly under pressure by the action of the pumps; they depend on the hydraulic head of sewage with a varying discharge. This 24-inch main is capable of discharging upwards of 5 million gallons in twenty-four hours, with a velocity of 3 feet per second, showing it is much too large for its work.

As to the open septic tanks. Mr. Greatorex has very wisely provided largely increased tank accommodation in his new scheme, and I agree with him that it will improve the capacity of the beds and reduce the silting up which is now going on in the experimental beds; but the question is, are they sufficient?

They are stated to hold 500,000 gallons, the average dry-weather flow on the low level being 800,000, about 62 per cent. of the day's flow.

I am now designing septic tanks to hold 1½ day's dry-weather flow, and I am confident this tank capacity will main-

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tain the water capacity of the primary beds for a much longer period than smaller tanks.

If you wish to maintain the anaerobic action, the sewage in the tanks should be as quiescent as possible, and this can only be effected by adequate tank accommodation.

I am aware this is largely a question of cost, and that engineers are debarred from designing large tanks owing to the difficulty they have in getting their schemes approved by their Councils.

As to the scum. I find it is essential to induce this as much as possible, as it increases the anaerobic action, and the tank effluent is in a better condition for the aerobic treatment on the beds.

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HOME DISTRICT MEETING AT ALDERSHOT.

October 11, 1902.

Held at the Aldershot Institute, Aldershot.

MR. W. WEAVER, M. INST. C.E., VICE-PRESIDENT, *in the Chair.*

The Members assembled at the Aldershot Institute, where they were received and welcomed by the Chairman of the Council (Councillor T. Jeffries, J.P.).

The Chairman extended a most hearty welcome to the Members.

Mr. W. Weaver, Vice-President, thanked the Chairman of the Council for the very kind welcome he had accorded to the Association.

The Minutes of the last Home District Meeting were read, confirmed and signed.

Mr. R. J. Thomas (Aylesbury) was unanimously re-elected as Honorary Secretary for the Home District.

The following paper was then read and discussed :—

SOME MUNICIPAL WORKS AT ALDERSHOT.

BY NELSON F. DENNIS, ASSOC. M. INST. C.E.,
ENGINEER AND SURVEYOR TO THE COUNCIL.

ALDERSHOT was constituted a Local Government District in 1858, which was the outcome of the establishment of the camp in 1853–54. The camp, originally a collection of wooden huts, now consists of fine blocks of brick and stone buildings and well-made roads and paths, named after various generals of

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note. Thought and attention have been given, in the laying out of the camp, to the provision of the many things calculated to make the life of the soldier cheerful, as well as useful. There are provided for him, reading rooms, libraries, recreation rooms, gymnasiums, swimming bath, recreation grounds, and various institutions where he can improve his general knowledge of things.

The married quarters are arranged on the tenement principle, of which there are some very good blocks.

The area of the Aldershot Urban District is 4177 acres; and, as an index of the rapid growth of the town, the rateable value has advanced from 79,000*l.* in 1898 to 130,000*l.* in 1902.

The average death rate for the ten years 1891–1900 was 16·9 per 1000.

Gas and Water Supply.

The water supply is under the control of the Aldershot Gas and Water Company.

The supply is derived from wells sunk into the chalk, and is ample in quantity and good in quality. The water is somewhat hard, being 16·8 degrees on Clarke's scale. The water charges are based upon the rental, 6 per cent. under 50*l.*, 5½ per cent. for 50*l.* to 100*l.*, and 5 per cent. above 100*l.*

The gas is 2*s.* 10*d.* per 1000 cubic feet.

In 1901 the Council were successful in obtaining the insertion of a clause in the Aldershot Gas and Water Act of that year, authorising the construction of a legal testing station for gas at the Council's offices, where the candle power of the gas must not be below 15.

Sewers.

Aldershot is a fully "water-closeted" town, and, now that the "contour sewer" is completed, provided with sewers for all parts of the district. The contour sewer, so called for convenience, was laid in 1901 for the purpose of encouraging the opening up of land for building purposes on the southern slope of the district, also to receive the drainage of a portion of the west end, then drained to two of Shone's ejectors. The latter were becoming insufficient to cope with the sewage due to increased building operations. The area of the district provided for

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by the contour sewer is 430 acres. The sewer was constructed of Hassell's single lined pipe and a short length of double lined, varying in diameter, commencing at the sewage works with 18-inch pipes and continuing for 5320 feet at a gradient of 1 in 410; 2000 feet of that length was laid in tunnel at a depth of from 25 to 43 feet below the surface. Shafts were sunk at every 150 feet, which were afterwards bricked up, circular on plan, for manholes. The progress of the work through the tunnel was slow owing to the loose and watery nature of the soil in a portion of the work; foul air had also to be contended against. Where the sewer was laid at depths from 9 to 15 feet the pipes were embedded in concrete to the half diameter, and at depths above 15 feet the pipes were encased in concrete. From the tunnel the size of the sewer is diminished to 15 inches at the fall of 1 in 330 extending for a length of 2640 feet. The remaining 3470 feet is of 12-inch pipes and the gradient 1 in 73. The cost of the sewer was about 6800*l.*, towards which the owners of land abutting on the line of sewer contributed 889*l.*, and free wayleave was granted where the sewer passes through private land for a length of nearly half a mile. The late Mr. George Osenten was the contractor. During the past four years 8300 feet of sewers have been laid in addition to the "contour sewer."

Separate System.—The rain-water from yards and the back portions of the roofs of houses flows into the sewers, but the front roof water and street water is collected on the "separate" system, which has been laid down in nearly every road in the district. The main surface drainage is discharged at two outfalls, one near the Government siding in the northern part of the district, and the other at Ash Bridge, near the sewage works in the southern part of Aldershot. The rainfall on one-seventh of the total mileage of roads is discharged at the former point, and about one-third at the latter. About one-seventh of the mileage of roads discharges the rainfall into sewers, and the balance finds its way into various watercourses which ultimately empty into the river Blackwater. The Government siding scheme was completed in 1898, and, with the exception of the portion of the work (1300 feet) constructed in tunnel, no special difficulties were encountered.

Sewer Ventilation.—It has always been the desire of the Council that the sewers should be made as perfect as possible, and the Author is pleased to be able to state that all the

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suggestions he has made for their improvement have been adopted by the Council. During 1899 a sum of 700*l.* was expended out of loan for the purpose of obtaining a better ventilation for the sewers. Prior to that year, there were twenty-one ventilators fixed at the sides of houses. Since then, forty-seven steel columns have been erected on the line of kerb. The columns were supplied by the Blackwall Galvanized Iron Company, and are 8 inches in diameter for the lower half, and the upper half is 6 inches in diameter. The shafts are 30 feet in height. Tests were made as to the efficiency of the ventilators, with satisfactory results.

Disposal.—The high standard of purity of the sewage effluent demanded by the Thames Conservancy, not to exceed ·1 albuminoid ammonia and 1·0 oxygen absorbed in 4 hours, required careful attention being given to the treatment; and although prior to the introduction of the bacteria system, when the sewage was being treated with chemicals and then passed over land, complaints were at times received that the effluent was not of the required standard, since the introduction of the bacteria system and the abandonment of chemicals the effluent has given no cause for anxiety. The experimental period, usual when the bacteria system is under consideration, was terminated about four years ago, and it was determined to adopt the contact beds for the treatment of the Aldershot sewage. Since then sufficient primary beds, and half the area of the secondary beds, have been constructed for the treatment of the whole of the ordinary flow of sewage. The works have been built by the direct aid of the rates, and not by loan. It has been found that the quality of the effluent is impaired by the compliance with the Local Government Board's requirement to pass it over land before discharging into the Blackwater. The land at the town disposal works is not what might be termed good, it being flat, and the level very little above that of the river Blackwater. The subsoil water at times is within two feet of the surface for a considerable area. Rye grass, for which there is little demand, is the only crop grown.

The sewage (the dry-weather flow being about 600,000 gallons per day) is raised from the pump well, a height of 18 feet, by means of centrifugal pumps, to a detritus chamber 24 feet long by 10 feet wide; and, without further treatment or screening, the

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sewage is conveyed along a carrier of brickwork, lined with Candy's vitrified buff bricks and supported on arches, to the series of primary beds, from which it is passed after due contact, varying from two to three hours according to the strength of the sewage, on to and through the secondary beds with continuous flow. The effluent then enters a carrier dug in the earth 6 feet wide, along which it travels for a distance of 600 yards to the outfall. The average rate of charging the primary beds with sewage is two and a quarter times per day.

There are thirteen primary beds, three of which are each 138 feet long, 24 feet 6 inches wide, and 5 feet 3 inches deep, and ten, each of the average dimensions of 57 feet by 35 feet by 4 feet 6 inches deep, a total area of 3344 square yards. The beds are enclosed with brick walls, 14 inches thick, with buttresses. The bottoms are of Portland cement concrete. The sewage is admitted to each of these beds by penstocks fitted in the middle of the long side, and falls over some large clinker lumps into the filter. Neither distributors nor sprinklers are employed, as the Author considers their use unnecessary. The filter medium consists of furnace clinkers graded from large lumps at the bottom, affording good drainage, to fine ashes at the top about 1 foot 3 inches thick. The outlet valves, fixed at the opposite side to the inlets, are of the ordinary 6-inch screw-down type, and upon being opened permit the primary effluent to flow into the low level secondary bed carrier. The primary effluent can be controlled in this carrier by penstocks so as to flow into any of the secondary beds, of which there are four at present constructed —two, each 100 feet by 57 feet by 2 feet deep (four more of this size are to be constructed); and two, 105 feet by 85 feet by 1 foot 9 inches deep. The filling of the secondary beds consists of a layer of coarse clinker at the bottom and the top 1 foot 2 inches of fine ashes. Neither difficulty nor trouble has been experienced in the working of the beds, and the permanent diminution in the holding capacity is not appreciable even in the bed that has been in continuous work for three years. For this satisfactory result every credit is due to Mr. Edwards, the works manager, who has throughout devoted his untiring energy to the ensuring of the success of the scheme, to accomplish which so much depends on management. The Author has come to the conclusion that the disposal of a town's sewage on the contact method of biological treatment cannot be left to the automatic

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machine, neither can it be entrusted to the inexperienced labourer. Elaborate arrangement of valves, feeding troughs, etc. are not essential to a successful result.

The surface depth, to about 10 inches of the primary beds, is delved over once a fortnight, and the deposit on the top near the inlet is raked off and burnt in the destructor. The total accumulation thus removed amounts to an average of five barrows per day for the whole of the primary beds. The secondary beds are harrowed once a week. The labour required for this necessary work is two men constantly employed.

The effluent has been good at all times and under varying temperatures, as the appended analytical data will testify.

The cost of the primary beds, inclusive of carriers but exclusive of the large tanks, has averaged 150*l.* each complete, and the secondary beds 220*l.* each. The value of the clinker and ashes is taken at 2*s.* per cube yard.

During wet weather, owing to the diluted state of the sewage, the holding up in the primary beds is reduced to about one and a half hours and the excess flow is passed into the storm-water tank, the overflow being treated on a storm-water filter. The latter has been completed only a few days, it is therefore impossible to say anything as to its efficiency.

Refuse Destructor.

Until October 1900 the collection and disposal of house refuse was done under contract. Since that date the work has been performed by the direct employment of labour, and the refuse disposed of in a Meldrum's destructor erected at the sewage works. There are two cells, each connected with the old Cornish boilers (which had previously been stoked with coal), worked in duplicate. The average quantity of domestic refuse collected per week is 58 loads, or about 68 tons 12 cwt.; but in addition to this the destructor deals with about 7 tons per week of trade refuse, which latter refuse the tradesmen have to cart themselves. One cell only is worked at a time. This quantity of refuse is more than sufficient for the requirement of raising steam to work the sewage pumping plant, and the Council are therefore considering the advisability of laying down an electric light plant, to enable them to light their works, and also thereby use up the spare steam. The average quantity of sewage raised

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ANALYSES OF SEWAGE EFFLUENTS. (Parts per 100,000.) THOS. DUNLOP, M.B., D.P.H., M.O.H., Aldershot.

—	Crude Sewage.						Effluent from Primary Filters.						Effluent from Secondary Filters.						Effluent as it enters River.					
	Chlorine.	Nitrites.	Nitrates.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Chlorine.	Nitrites.	Nitrates.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Chlorine.	Nitrites.	Nitrates.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Chlorine.	Nitrites.	Nitrates.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.
1901.																								
January ..	8·6	..	..	3·4	·38	3·7	8·4	nil	·76	2·24	·18	1·14	8·0	nil	1·60	·39	·07	·26	8·6	nil	·86	1·30	·16	·92
February	10·6	..	..	4·5	·54	3·7	7·0	..	·91	1·34	·08	·77	7·2	..	·70	1·33	·04	·35	6·8	..	·20	2·83	·13	·85
March ..	9·4	..	..	9·8	·69	3·8	6·8	nil	·34	2·70	·09	·65	7·4	trace	1·50	·44	·04	·30	8·2	nil	·35	3·44	·16	·87
April ..	..	..	..	5·6	·38	..	8·9	..	..	2·30	·24	1·08	8·7	nil	·50	·39	·04	·44	9·0	..	..	2·00	·10	·90
May ..	12·0	..	..	7·9	·46	3·2	9·6	nil	·05	5·00	·24	1·60	9·2	trace	1·34	1·57	·09	·50	9·8	trace	·76	2·16	·13	·82
June ..	..	..	..	7·0	·35	3·7	9·9	nil	·16	4·50	·08	1·29	8·7	trace	1·94	·28	·05	·35	9·8	trace	1·10	3·13	·11	·80
July ..	8·5	..	..	9·5	·45	3·9	7·4	nil	·12	3·30	·08	·61	8·0	trace	1·15	1·62	·05	·40	8·8	trace	·40	2·98	·09	·88
August ..	9·8	..	..	5·4	·35	2·9	9·5	nil	·08	2·30	·15	1·20	8·9	nil	1·13	1·49	·05	·37	9·9	trace	·62	3·86	·12	·90
September	10·4	..	..	4·2	·42	2·9	8·5	trace	·23	2·00	·08	·74	8·5	trace	·92	·58	·04	·31	9·6	trace	·69	2·36	·08	·75
October ..	13·5	..	..	4·7	1·00	4·6	8·2	trace	1·0	2·90	·12	1·30	7·5	trace	1·62	·76	·05	·28	8·6	trace	·50	3·40	·12	·80
November	12·6	..	..	8·4	1·00	6·5	7·0	trace	·34	2·40	·23	·83	7·0	nil	·73	·51	·06	·33	8·4	nil	·48	1·91	·11	·63
December	11·7	..	..	8·8	·44	3·3	8·1	..	..	2·70	·09	·30	8·8	..	..	1·90	·05	·30	8·5	..	..	2·90	·12	·83
1902.																								
January ..	10·7	..	..	6·6	·53	3·8	8·2	..	·40	2·80	·14	·95	8·1	..	1·20	·93	·05	·34	8·8	..	·54	2·70	·11	·82
February	12·6	..	..	6·7	·32	5·0	9·2	trace	trace	2·30	·11	·80	8·6	..	1·06	1·0	·07	·33	10·4	nil	trace	1·78	·14	·85
March ..	10·8	..	..	9·8	·55	3·8	7·4	trace	·69	2·68	·09	·65	7·8	..	·99	·4	·04	·30	7·8	..	·25	2·95	·09	·87
April ..	10·6	..	..	6·5	·26	4·0	10·2	trace	·34	4·18	·12	1·20	9·4	..	1·2	1·75	·06	·42	9·6	..	·42	4·4	·11	·78
May ..	11·0	..	..	12·0	·34	3·1	10·1	trace	·40	4·60	·20	1·02	9·5	..	1·2	·92	·06	·38	10·2	..	·33	5·34	·13	·98
June ..	11·5	..	..	5·9	·24	3·8	7·9	trace	·38	1·79	·07	·85	7·6	..	·96	·91	·06	·35	8·3	..	·12	3·70	·12	·81
July ..	12·4	..	..	6·2	·68	3·3	10·4	trace	·08	2·90	·09	·58	9·8	..	1·01	·64	·05	·28	10·2	..	·96	1·72	·06	·58
August ..	12·4	..	..	10·3	·34	5·0	10·9	trace	·03	3·9	·28	1·2	9·8	..	·92	1·15	·05	·41	11·2	..	·35	4·79	·11	·81
September	14·6	..	..	8·4	·50	3·8	10·6	trace	·76	3·1	·12	·72	10·4	..	1·03	·43	·05	·31	11·5	..	·12	5·8	·12	·78

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per day is about 800,000 gallons. The grate area of each cell is 33 square feet. The old chimney stack, which is 70 feet high and 2 feet 6 inches in diameter, is ample for the work it is called upon to perform, and no complaints have been received from residents in the neighbourhood of the destructor. The cost of the works, including the inclined roadway and the slight alterations necessary to the old boiler-house, was 1200*l.* The cost of working the destructor is 1*s.* 2*d.* per ton. The additional cost of stoking with refuse, over the cost incurred when the boilers were stoked with coal, is 3·66*d.* per ton of refuse; but it must be noted that, on the other hand, the destructor has done away with the previous consumption of coal, amounting to 350*l.* per annum. The clinker produced, amounting to about 30 per cent. of weight of refuse destroyed, is at present being used in the formation of bacteria beds, and can therefore be reckoned as a valuable asset.

The work of collection is so arranged that the refuse is removed thrice weekly from every house, and also that this work will be finished before noon each day. The desirability of providing each house with a proper covered portable sanitary ash-bin, and thereby doing away with the most varied assortment of receptacles now employed by the householder, is occupying the attention of the sanitation committee.

The cost of house refuse collection is 2*s.* 8*d.* per ton.

Open Spaces.

An open space of 9 acres has been recently acquired in the centre of the town for a sum of 5200*l.* In addition to the electric light works, which occupy a portion of the land, the Council have adopted plans for a fire station and public offices to be erected on the Grosvenor Road frontage, and the stables and depôt on a portion of the land adjoining the electricity works. The remaining area is to be fenced in at a cost of 2000*l.* and laid out as a pleasure ground. The only other open space possessed by the Council is the recreation ground, area 10·7 acres. Aldershot is, however, blessed with plenty of breathing room in the shape of large areas of copse land, over which the public are permitted to walk.

Depôt.

The new stables and depôt are designed to accommodate seventeen horses. The width of the stables is 30 feet and the

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height 13 feet. The stalls are 7 feet in width, and will be paved with concrete. The cart sheds, of which there will be two, each 50 feet by 30 feet, will be covered with slates on iron principals supported on cast iron columns; a third cart shed occupies a portion of the brick buildings. The paving of the cart sheds will be of blue Staffordshire bricks laid on Portland cement concrete. That portion of the depôt over which the heavy traffic will pass will be paved with granite setts and the remaining area with tarred macadam. Provision will be made for two steam rollers, cement store, tool house, yard office, forge and workmen's mess room, harness room, general stores and the usual conveniences. The caretaker's quarters will be at the entrance to the depôt. The elevation to the road, occupying a frontage of 120 feet, will be of brick with Mansfield stone dressings, and will, as far as possible, be in keeping with the elevation of the electricity works adjoining. A tender of 3085*l.* has been accepted for the work.

Electricity Supply Works.

The electricity supply works, for which the Author acted as consulting engineer, were inaugurated in May 1902, and so well has the public supported the undertaking, that at the time of writing there are 80 consumers connected, and the revenue is sufficient to cover all working expenses.

The works are situated on the south-east portion of the Parish Clerk's Land. In designing the buildings, all extravagance in adorning the elevations was avoided. The engine-house has a brown glazed brick plinth and a white glazed brick dado 4 feet 6 inches high, finished off with a chocolate-brown reeded brick. The walls are built of white pressed bricks, which gives a light and cheerful appearance. Piers are built 9 feet 8 inches centre to centre, which terminate under the corbelling that supports the oak running beam, upon which the crane rails are fixed. The engine house is 50 feet by 30 feet, which affords room for doubling the present engine power. The boiler house is 41 feet by 45 feet. The offices, engine house and boiler house adjoin, and are parallel to each other; the engine house occupying the middle position. The accumulator room is placed under the offices, which latter, together with the entrances, extend for the whole frontage to the road.

The boiler house contains two Babcock and Wilcox boilers,

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each with seventy-two tubes 18 feet long and 4 inches in diameter. The heating surface of each is 1619 square feet, and the grate area is 39 square feet. Each boiler is capable of evaporating 5000 lbs. of water per hour at a working pressure of 160 lbs. per square inch. The main flue is 4 feet 9 inches high by 4 feet wide. Some trouble has been experienced with the fire-bars, owing to the excessive burning away due to the intense heat of the Welsh smokeless large coal used, which very quickly freezes on to the bars and runs in between, thereby partially stopping the draught, when the bars at once commence burning at the tops. Constant pricking with a long tool from underneath helps, but does not prevent the bars from burning fairly rapidly. Arrangements are being made which, when completed, will it is hoped, remove the cause for so frequent renewals.

The main steam pipes are arranged on the "ring" system, and are 6 inches in diameter and $\frac{1}{4}$ inch thick. The exhaust piping is 12 inches in diameter.

One Pulsometer surface condenser, having 850 square feet of brass tube surface, is provided, capable of dealing with 300 B.H.P. There are two Worthington feed pumps, each capable of feeding two boilers when working at full capacity. A Baker's oil extractor is inserted in the main exhaust pipe before it reaches the condenser. In the vertical exhaust pipe in the engine room is fixed a "Bailey's" atmospheric balanced valve, which automatically opens the exhaust to atmosphere in case of the condenser failing. Outside the boiler house there is a cooling pond, 40 feet by 80 feet by 4 feet 6 inches deep, for the condenser circulating water. The pond is connected to a system of surface water drainage, which receives the water from house roofs and roadways of a residential part of the district. There is a connection from the pond to the hot well, to avoid as far as possible the use of town's water, which is very hard for boiler purposes. A Green's economiser of 144 tubes is provided, the scrapers of which are driven by a "Parker" enclosed motor of 2 B.H.P. The economiser was designed to deal with a boiler power much greater than that at present installed. The chimney shaft is 110 feet high and 5 feet internal diameter. The fire brick lining extends to a height of 40 feet. Gunmetal steeplejack-hooks are built into the external face at every 8 feet in height.

The engine house contains three Willans-Parker sets, each

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of 90 kw. capacity, which deliver current to the outers of the three-wire system at 420 to 460 volts. The balancer and boosters are four "Parker" machines, all coupled on the same shaft, and this is placed close up in front of the switchboard platform. The two boosters are for charging the two halves of the battery, and are driven by either or both of the balancer armatures—the output of each is 40 amperes at from 10 to 100 volts, the normal charging current being 30 amperes. The output of each balancer armature is 40 amperes at 210 volts, which is capable of dealing with an out-of-balance current of 75 amperes on either side of the system. The switchboard is of "Parker's" usual three-wire type, with the central panel for the middle wire connection, and the outer panels for the positive and negative connections and 'bus bars respectively. All the switchboard instruments are Kelvin's. All fuse pillars are fitted with winged thumb-nuts, which enables fuses to be renewed easily and quickly, without the risk of short circuits attached to the use of spanners on the old form of hexagonal nuts. In each dynamo circuit there is a B.T.H. recording wattmeter, for measuring the total output, and the battery meters are of Chamberlain and Hookham's latest charge and discharge type, with ratchet and pawl attachments. In addition to the main switchboard there is a smaller distribution switchboard containing the recording Kelvin voltmeters and terminals for recording the pilot voltage at any of the feeding points. Also one Kelvin earth current recording ammeter, with switch and fuse device to short circuit the instrument if overloaded; two arc lamp ammeters, switches and fuses, each controlling a series of four lamps in the town. These are "Oliver" ten ampere double carbon lamps, and are at present in two series of four across 210 volts. There is also on this smaller board a throw-over switch for all station lighting, etc., 'bus-bars and fuses. There is a small switchboard in the general office for testing purposes, with its various instruments, and all connections are brought to terminals on the front of the board, with thumb nuts.

A D.P. battery of 244 cells each of 11 plates, and of 300 ampere-hour capacity, is provided. The normal charging current is 30 amperes, and the rates of discharge are 75 amperes for two hours, 50 amperes for five hours, and 30 amperes for ten hours. There are 12 cells of the same size, fitted up as a meter

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testing battery and for charging small accumulators for motor cars, etc. It also serves as a hospital battery to the main battery.

All feeders, distributors, arc and service cables, are Callender's V.B. cables laid in wood troughs, run in solid with bitumen and protected with a hard tile cover 1¼ inch thick. There are two ·4 square inch feeders run to the centre of the town, each 2000 feet long; one ·2 square inch neutral, and a 3-core pilot wire to each feeder point. The distributors are ·10 ·06 ·10, ·06 ·06 ·06 and ·035 ·012 ·035. There is a third feeder, ·25 ·10 ·25, feeding a small network of distributors in a residential part of the district. The cost of distributors and feeders (exclusive of arc lighting) worked out, on the length of the distributors, only at 1850*l.* per mile complete.

Chamberlain and Hookham meters, and Reason Manufacturing Company's max. dem. indicators, are used entirely for consumers' premises, with the exception of a few small consumers who are connected up with "Rochdale" penny-in-the-slot meters.

The charge for current for lighting purposes is at the rate of 6*d.* per unit for the first hour at maximum demand, on "Wright's" system, and 4*d.* per unit for all in excess. For motive power the charge is 3*d.* and 2*d.* per unit, on the same system. The average price obtained from private consumers, from May up to the present time, is practically 5*d.* per unit. Arc lamps for public lighting are charged at 16*l.* per lamp per annum, lighted until one o'clock at night; and incandescent electric street lighting is charged at 2*l.* 15*s.* per lamp per annum, lighted until 2.30 a.m.

At present only 8 arc lamps are erected, in two series of four across 210 volts, with the "live" switch leads of each circuit brought back to the station, and the "town" ends of each circuit tapped on the neutral distributor. Eight more lamps are to be erected, and this can be done by converting each of the present circuits into a circuit of 8 lamps, and tapping the "town" ends on to the opposite live distributors, and disconnecting the neutral connections. All these lamps are to be erected along the lines of route of the present 2 circuits, so that it will be unnecessary to lay any extra cables for them.

The house services are laid by the Council without charge to the consumers, and meter rents are not levied unless the annual bill for current used is less than 3*l.*, when rents will be charged at 8*s.* per annum.

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The total cost of the installation per 8 candle-power lamp, which the plant is capable of supplying at the same time, works out at 2*l.* 10*s.*

A loan of 20,000*l.* was obtained for electric lighting purposes, to be repaid in 25 years. The contract amounted to:

	£	*s.*	*d.*
Boilers, condenser, economiser, pumps and pipe-work	3,992	0	0
Engines and dynamos	3,390	0	0
Balancer-booster, switch-board and connections ..	1,495	0	0
Battery	806	0	0
Crane and spare parts	424	0	0
Mains, and eight arc lamps	3,950	15	0
Buildings and shaft	3,615	0	0
	17,672	15	0

The remainder of the 20,000*l.* goes for contingencies, excavation for cables (which was a separate contract from the mains themselves), service connections, meters, indicators, etc.

Mr. George Kemp, Aldershot, was the contractor for the buildings, and Messrs. Thomas Parker, Limited, of Wolverhampton, were the contractors for all the plant and cables.

Mr. O. F. Francis was Messrs. Parker's resident electrical engineer during the construction of the works, and also during the first six months' running of the station, which was carried on by Messrs. T. Parker, Limited, under contract with the Council, on the minimum unit guarantee principle. He has since been appointed by the Urban District Council as their electrical engineer.

Public Lighting.

The public lighting is at present done by 8 arc lamps; 10 electric incandescent lamps (two 16 candle-power burners in each lantern); and 316 gas lamps, of which 156 are incandescent, the No. 4 kern burner being principally used. The gas lighting is carried out on the average meter system. There are 11 lamps to each meter lamp. The consumption of gas, based upon a year's average, is in the proportion of one for ordinary 5 feet burners to ·93 for incandescent burners, but the Author finds the annual total cost of incandescent lighting to be 4 per cent. more than ordinary burners per lamp. The price of gas for public lighting is 2*s.* 10*d.* per 1000, less 10 per cent.

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Isolation Hospital.

In 1898 a site of three acres was purchased for the erection of an isolation hospital, and the Author prepared plans, etc., for a complete scheme, but at that time the Council considered it advisable to proceed with the erection by stages, defraying the cost out of the current rates.

Under that method, a portion of the administrative building was erected, and the No. 1 ward block and the disinfecting chamber completed.

It was, however, decided in 1900 to apply to the Local Government Board for their sanction to a loan for the complete scheme, including the cost of the building already erected. Sanction was obtained as applied for, and contracts for additional buildings were entered into.

The accommodation provided for, consists of administrative block, two ward blocks (one of eight beds and the other ten beds), an observation ward (four beds), discharging ward, a disinfecting chamber, and laundry, mortuary and porter's lodge.

The administration block has on the ground floor a doctor's room, dispensary, matron's sitting-room, nurses' dining-room, three nurses' bed-rooms, larder, kitchen, scullery, and the usual offices. First floor: nurses' sitting-room, doctor's bed-room, matron's bed-room, science-room, and five nurses' bed-rooms, also bath-room and water-closet. On the second floor accommodation is made for four bed-rooms for nurses and servants, also tank and box-room. In each of nurses' bed-rooms there is fixed a hand basin with hot and cold water laid on. The linen-room contains the hot-water tank and piping, which is convenient for keeping linen, etc., aired.

It will be seen that the administrative building is provided with sufficient accommodation for a resident medical officer and nurses during epidemic times, even were it necessary to erect temporary extensions to the permanent buildings.

Provision has been made for the isolation of scarlet fever and diphtheria patients. Owing to the extreme rarity of enteric fever, the average for the last nine years being four per annum, it was not considered necessary to make special provision. No. 1 isolation block consists of male and female wards of four beds

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each, and No. 2 isolation block has four beds in one ward and six in the other. Each of these buildings has a nurses' duty-room and bath-room. The closets and bed-pan flushers are separated from each ward by a passage, having through ventilation, and a separate entrance from the grounds.

The walls and ceilings of the wards are rendered with Robinson's cement. All angles are struck to a 3-inch radius. The floors are of pitch pine, in narrow widths, and beeswaxed. The ventilation is effected by Kite's extractors, the inlets being provided by Tobin's tubes, fixed between windows and at the end of wards; warm air is also admitted through Manchester ventilating stoves fixed in the centre of the wards. The air space per bed is 2000 cubic feet, and the experiments made by Dr. Dunlop, the medical officer of health, in conjunction with the Author, as to the efficiency of the ventilation, showed that the air of the ward was changed three times per hour, the internal temperature being 64° and the external 40°.

The observation ward, which is for the reception of two male and two female suspected cases, is constructed similarly in detail to the isolation blocks. The discharging ward is a small building containing two rooms separated by a bath-room.

The disinfecting chamber is fitted with one of Washington Lyon's disinfectors, "M" size; the internal dimensions are 7 feet in length, 4 feet 2 inches in height, and 2 feet 7 inches in width. An exhaust apparatus is provided for quickly exhausting steam from the machine and passing a current of hot air through the disinfector. The cost of the machine, including vertical boiler and erection, was 215*l.*

The laundry when erected will contain a small hydro extractor, a washing machine, three washing troughs and a steam boiling trough, also three drying horses. An ironing-room adjoins the washhouse.

The cost of the sanatorium complete, including fencing in site and furnishing, works out at 273*l.* per bed.

Main Roads.

There are 5·71 miles of main roads, 1·75 miles of which are coated with local pit flints and 3·96 miles with Cherbourg quartzite. The County Council pay to the District Council the whole of the actual expenditure on maintenance, 50 per cent. of

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the cost of permanent improvements, and 5 per cent. for establishment charges. An allowance is made of 252*l.* for scavenging, and 52*l.* for watering. The average annual expenditure for the past three years was 2250*l.*

The Cherbourg quartzite is an excellent material for the coating of the greater portion of the main roads; but it does not wear so well as some other granites on roads subjected to heavy horse traffic, due to the passing of cavalry or artillery.

Quenast has for a number of years been used in re-coating the principal roads in the town. Other roads are repaired with broken gravel obtained from the Council's pits.

Private Streets Works.

The Private Streets Works Act has not been adopted. New streets are, as a rule, made up of local gravel for the carriageways. The channels, 15 inches wide, are of Tees scorial bricks, laid on 6 inches of concrete. The kerb is Norway granite, 6 inches by 12 inches, and the footways are paved with concrete made as follows: Concrete foundation, 4 inches in depth, composed of six of clean shingle to one of Portland cement. The topping, 1½ inch thick, is composed of five parts of fine granite chippings to two of cement. The whole, when thoroughly consolidated, is left with a true and even surface.

The paving is divided into bays, 5 feet wide, by wood splines.

The cost per foot frontage, including surface drainage, varies between 10*s.* and 12*s.* The material, laid complete, costs: granite kerb, 2*s.* 3*d.* per foot; channelling, 1*s.* 8*d.* per foot run; concrete paving, 4*s.* per yard super; crossing, of 3 inches by 5 inches granite setts, laid on 6 inches of concrete, 16*s.* per yard super.

New Public Roads and Improvements.

The Council has determined to construct a new roadway, 36 feet in width, with concrete footways on either side, along the southern boundary of the Parish Clerk's Land as far as the electric light station. The road will have the effect of increasing the rateable value of the property known as Laburnum Terrace, consisting of about thirty-three cottages. In the year 1900 Barrack Road was widened for a length of 310 feet, the old carriageway, 22 feet in width, was increased to 39 feet, and a

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concrete footway of 10 feet wide constructed on the east side. The same year High Street, for a length of 810 feet, was widened by 5 feet. In 1901 Eggar's Hill was widened, for a length of 310 feet, from an average width of 28 feet to 38 feet. Boxall's Lane was widened to 36 feet throughout its length of 900 feet, the former width being only 20 feet average.

Watering and Scavenging.

The district, for scavenging purposes, is divided into seven areas, each having its scavenger, who collects the sweepings into a covered hand cart. It is not always an easy matter to dispose of the sweepings in certain districts, but this difficulty is small as compared with the disposal of the slop and slurry collected during wet weather, as, owing to the closing of some of the local tips, it is becoming an expensive item to get rid of.

An experiment was made with a sample of slop from a granite road (Ash Road), to ascertain if the dry material could be turned to good account, but the result was not encouraging :—

Weight of slop	26·85
„ when moisture expelled	19·81
„ when organic matter extracted	19·02
Percentage of moisture in slop	26
„ of organic matter after moisture expelled ..	4
Weight of granite particles, etc., retained on sieve, 900 meshes to the square inch	2·05

It will be seen that in about 27 tons of slop, with but a comparatively small amount of moisture in it, only two tons could be called useful material, and the expense of obtaining this would not be commensurate with its value.

The street watering is now done by the aid of six water vans and water carts, the quantity of water used being ascertained by meters fixed at each standpost. The price paid is 1*s.* per 1000 gallons, with a discount of 20 per cent.

Three of the water vans have rotary distributors, which are satisfactory in their working on carriageways of 24 feet and upwards in width, but in narrow roads the water is thrown on to footways, much to the annoyance of pedestrians. These water vans will throw the water from 12 to 14 feet on either side of the fans.

The Author is indebted to Lieut.-Colonel H. J. W. Jerome, C.B., Commanding Royal Engineers, South Camp, Aldershot, for the following notes.

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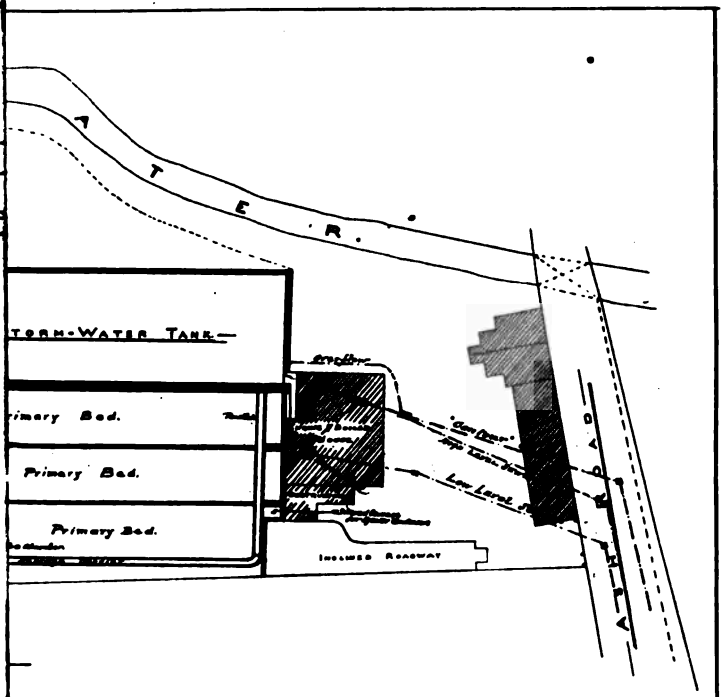

RICT COUNCIL —

ACTERIA BEDS

Engineer & Surveyor Rhos Council

Aberdare.

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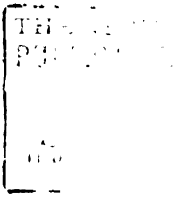

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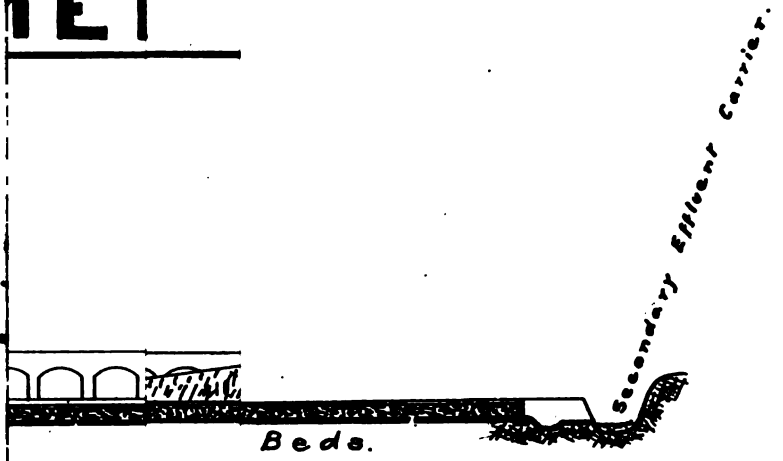

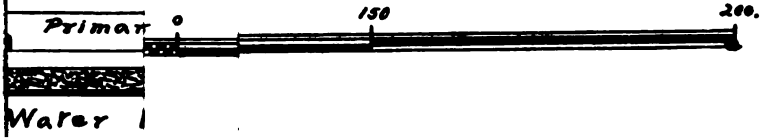

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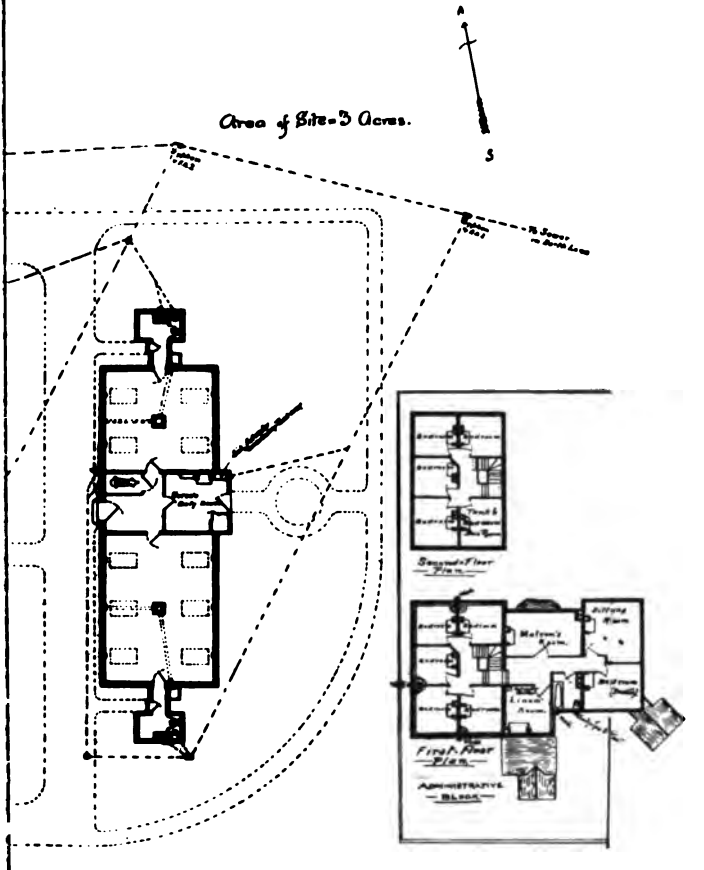

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Central Clothing Store.

Built in order to form a centre for the issue of all articles of clothing required by the First Army Corps.

Building commenced on November 26, 1900. Contractors for the building only, Messrs. Martin Wells and Company.

Building consists of eight large and two small store-rooms, and two office-rooms. It is provided with five baling presses on the ground floor, worked by hydraulic pressure. There are two electric lifts, supplied by Messrs. Easton, Anderson and Company, the current being derived from the central electric lighting station.

The construction is fireproof throughout; armoured fireproof doors, which close automatically when the temperature exceeds 155°, are hung between the main store-rooms, and a complete sprinkler installation is laid over all the ceilings.

Details.—Two large store-rooms, 120 by 40 feet: six, 80 by 40 feet; one, 40 by 40 feet; and one, 40 feet by 22 feet 6 inches.

Basement.—Boiler for heating apparatus, 10 by 4 feet, by Haden and Company, Trowbridge.

Machinery.—Two hydraulic pumps, working to a high and low-pressure of 1680 lbs. and 150 lbs. The first, with three plungers of 3 inches diameter and 4 inches stroke; the low-pressure pump plungers of 3 inches diameter and 6 inches stroke; two open-type bipolar continuous current motors, of 20 B.H.P. and 15 B.H.P. series wound with multiple field coils; and two accumulators, one made for a working pressure of 750 lbs. per square inch, and one for 1680 lbs. per square inch.

Accumulators are placed in cast-iron tanks, and fitted with tappet gear for actuating switches for regulating the motors.

Baling Presses.—There are five of these in the packing and issue room, having rams of 9 inches diameter with a maximum stroke of 5 feet. When working with the maximum pressure of 1680 lbs. per square inch the load on the ram is 47 tons. They are drained through the floor. Pumps, rams and presses are all supplied by Messrs. Hayward-Tyler and Company.

Lifts and Motors.—Are supplied by Messrs. Easton, Anderson and Company, Erith.

The two lifts are designed to carry 10 cwt., and are worked each by its own 6 H.P. motor. The controlling gear is of the reversing type, actuated by a hand-rope of steel hemp-covered

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wire from the cage. The lifts are balanced by weights, and automatic safety gear provided.

The motors are compound-wound reversing. They are started, stopped and reversed by means of a controlling chain passing over a sprocket wheel, and worked by a man in the lift.

This chain is also worked by tappet discs keyed on to it for automatically stopping the motor when the cage reaches the top or bottom of the lift.

The Sprinkler Installation.—This fire-extinguishing apparatus has been supplied and fixed by the Grinnell Sprinkler Company. It consists of a network of water pipes, laid on to the ceilings, to which are attached a number of "sprinklers" or roses, formed of a composite metal which fuses when the temperature in the room exceeds 155°. As soon as any sprinkler fuses, the circulation in the mains of the system actuates a motor, through an automatic alarm valve, and the motor sounds an alarm gong fixed outside the building, the alarm continuing so long as water is discharged. Waste and testing valves, and two pressure gauges, are also supplied. There are about 350 sprinklers in all.

Fireproof Doors.—These are supplied by the same firm, and made to run down sliding rails in the same manner; that is, by the release of a counter-weight which falls when a fusible plug by which it is attached to the door melts.

The doors are faced with tinned steel and backed by hardened wood of three thicknesses, the grain in each thickness running a different way.

Heating System.—The radiators and hot-water piping valves, etc., were supplied by Messrs. G. N. Haden and Company, of Trowbridge.

The return pipes are covered with the Mica Company's patent mica composition.

Ceilings.—These are formed of expanded metal, with patent Sirapite plaster.

Floors.—These are of 2-inch yellow deal on creosoted joists, the planks being bedded in bituminous composition laid on concrete.

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Aldershot Camp Electric Lighting.

In the problem of supplying electricity for the requirements of a military camp such as Aldershot exceptionally exact data were available, and the shape of the load curve could be made out as a working basis.

The system of distribution adopted was by direct current on a three-wire network, the pressure at lamp terminals being 200 volts.

The camp was divided into twenty-eight sub-divisions. The total number of points to be wired for, irrespective of the number of lamps per point—many being three and five—is about 14,000.

No particular system of wiring is adopted, but in soldiers' quarters and buildings generally, where internal brickwork is merely whitewashed, the conduit system is used; on plastered walls, where work is on the surface, the conductors are laid in casings; in many cases of long runs in roofs the wires are supported by porcelain cleats.

Although it is proposed to earth the middle wire of the network, no difference is permitted in its insulation or protection in the wiring circuits, each side of the three-wire system is treated as an individual installation at 200 volts.

All switches and single pole fuses (if any) are placed on the outer conductor, which result is obtained by the use of red and black wires, the red being the outer in every case.

Power circuits taken into buildings are kept distinct from lighting circuits, and are connected up to the outers, all motors being wound for 400 volts. There are at present installed motors aggregating 100 B.H.P., but this is likely to be considerably increased.

The distribution network consists of two complete ring distributors, one for Stanhope and one for Marlborough lines, each supplied by several feeders. These rings are each provided with a number of distributing points, at which are placed pillar boxes, a certain number of these being also feeding points; the branch distributors are connected with the pillar boxes, and are arranged so that each barracks may be separately metered and controlled.

The mains are three core or concentric cables insulated with paper, lead covered, and laid solid in stoneware troughs. Where

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road crossings occur at places subjected to heavy traffic, the troughing is of cast iron with cast-iron covers.

The street lighting circuits are kept entirely separate from the remainder, and are provided for by single cables for the arc and twin cables for the incandescent lamps.

The main road through the camp, viz. the Queen's Avenue, will be lighted by thirty-two arc lamps, the columns being each fitted with two incandescent lamps as an alternative; the remainder of the roads will be lighted with incandescent lamps, two on each post.

Service boxes on buildings are in the majority of cases on the outside walls, this is brought about largely by the general absence of cellars, by the requirements of the War Department as to switch control, which is conveniently arranged for by an external switch; and generally as a protection from fire.

The steam generating plant consists of six water-tube boilers set in pairs in brickwork; their evaporative capacity is each 5000 lbs. of water per hour, with feed water at 112° F., to a pressure 160 lbs. per square inch. The feed pumps are in duplicate, each set consisting of a three-throw pump actuated by a multipolar motor, series wound, water being taken either from an overhead tank of five thousand gallons capacity (into which the condensed water is returned) or from the cooling pond. The arrangement of the feed piping provides for a duplicate service either through the economiser or direct into the boilers. The economiser consists of two double sections, each of 192 vertical tubes, and is arranged with a junction pipe so that both sections may be used singly or in parallel, or the sections may be placed in series with each other. There is no by-pass in the economiser chamber, but there is an entirely separate underground flue for use during repairs. The boilers are arranged for firing with coal by hand under natural draught. It is estimated that five boilers will deal with the load, and that one may therefore always be down for cleansing; consequently five bunkers are provided, each having a capacity of about 10 tons without stacking. In addition to the bunkers it is intended to build a coal store of 500 tons capacity as a stand-by; and a narrow gauge railway laid in front of the boilers will be used for conveying purposes. Inside the boiler house, near the entrance, the trucks pass over a weigh-bridge.

The quantity of water pumped into the boilers is measured

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by passing through duplicate water meters under pressure; and the quantity of condensed water, equivalent to that used in the engines, by passing through a meter after leaving the hot well.

The electrical generating plant consists of three sets of 250 kilowatt and one set of 100 kilowatt capacity; the dynamos are bipolar, and the armatures direct driven by turbines.

The 250 kilowatt sets generate at 400–450 volts, and are coupled direct to the outers of the network; the 100 kilowatt is a tandem set, with two dynamos, each generating at 200–225 volts, the terminals being connected with the three-wire for acting as a steam balancer. The main steam pipes are in duplicate, and provide two distinct means of supplying the separator columns connected with the turbines. These separator columns are fitted with automatic traps of the thermoscopic type, arranged for returning condensed water to the feed tank, and also with water gauges for hand working. Similar traps are fitted to the main steam pipes on the boiler-house side. The exhaust steam is led through stop valves to a common exhaust pipe, running in a subway underneath the engine room floor, and thence to the condensers, which are in duplicate, or through an automatic valve to atmosphere.

Circulating water for condensing purposes is brought by gravity from an adjacent cooling pond, and pumped back again by two centrifugal pumps. These form part of the duplicate motor-driven combined pumps, which deal with the air and hot water delivery and also the return from the hot well to the feed tank referred to. The capacity of each combined pump with its condenser is the exhaust steam of one 250 kilowatt set at full load.

The balancer-booster consists of four bipolar machines coupled together, compensates for 100 amperes out of balance, and the booster will raise 375 amperes on each side of the three-wire system from 0–100 volts.

The switch-board provides for three panels and one spare for the 250 kilowatt sets, one panel for the 100 kilowatt sets, one for the balancer, and two (one positive and one negative) for the battery, twelve feeder panels and two spare, two panels for combined pumps, two for feed pumps and economiser motors, and one for station lighting.

The whole of the control of the electrical plant, except the feed pump and economiser motors, is from the switch-board.

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In the generating station the boiler house is parallel with the engine room, both being of similar dimensions, viz.:—

Length 65 feet, breadth 46 feet 10 inches, and height 26 feet to the wall plate. Each is lighted from a skylight in the roof glazed with Mellow and Company's patent "Eclipse" glazing and ¼-inch rough plate glass, ventilating louvres run along the whole length, which, in the case of the engine room, may be open or closed.

In addition to the top lights there are windows in the outer walls above the crane rail. The pump room, 16 feet by 12 feet, and stokers' room adjoining, with tank over, and the economiser chamber, 35 feet by 21 feet 7 inches, are on the south end of the boiler house, while the offices, workshops, stores and test room are on the same end of the engine-room. At the north end of the engine room is the condenser pit; this runs the full width of the engine room, is 14 feet wide and 11 feet 6 inches deep, it is approached by means of an iron staircase leading under the north end of the switch-board gallery, from which access is also obtained from a landing to the cable-chamber, which runs under the remainder of the switchboard gallery. Behind the switchboard gallery, which runs lengthways in the engine room, lies the accumulator house, forming an eastern wing, the dimensions of which are 43 feet 6 inches by 43 feet. The roof of the accumulator house is in two spans, each provided with a glazed skylight with fixed open louvres. Light and ventilation are also provided by windows round the walls, which are treated with Blundell's petrifying liquid. The floor is paved with Candy's 32-panel buff vitrified paving bricks, a lead-lined sink of special design is provided for plate washing whereby all sediment is retained for examination, etc., in a stone-ware receiver. The engine room is paved with red Ruabon tiles, laid herring-bone pattern, the walls being glazed brick to a height of 13 feet, above which the bricks are light buff. The glazed brickwork is in two colours, Candy's French green for a height of 6 feet, the remainder being white; the edging of the machinery foundations is a glazed green bull-nosing to match.

The front of the switchboard gallery is panelled with white centres, upon which are mounted the station wattmeters. A six-ton travelling crane on rails, supported by wrought-iron stanchions, traverses the engine house and condenser pit.

Opening on to the gallery are the offices of the engineer on

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watch, the passage leading to the remainder of the offices, and the test room—from each of which, through plate glass windows, the engine room may be viewed.

In the boiler house, a cross gallery runs the whole length of the boilers, and gives access to the stop valves; the top of the economiser and the feed tank are also approached by the same means.

Separate rooms, each fitted with a lavatory and water-closet, are provided for engine-room and boiler-house staff, leading from their respective houses.

The boiler house is paved with blue Staffordshire bricks, the walls for a height of 6 feet being of the same material, the remainder of the walls, as well as the interior of the economiser chamber, pump room and mess rooms, being treated with petrifying liquid. The floors of the pump room and stokers' room are also in blue Staffordshire bricks.

The bunkers, which are on the outside of the boiler house, are protected by a lean-to galvanised iron roof, and have raked bottoms and sides to facilitate handling the coal through the bunker doorways, which are shut by sliding iron doors and communicate with the firing space in front of the boilers.

Four separate sumps are provided for the boiler blow-off pipes, and are arranged so that it is impossible for steam during blowing-down operations to find its way into a boiler laid off for cleaning. Access to these sumps is made through manholes with locked covers, and each is provided with a four-inch vent pipe to carry off any pressure caused when blowing down. The economiser blow-off is dealt with in a similar and separate sump.

The arrangement of duplicate flues enables repairs to the economiser, which is placed in the main flue, or to the flues themselves, to take place at any time. Access is obtained at both ends by double seal iron doors, while at the chimney end is provided a double damper with vanes at right angles to each other, mounted on and actuated from outside by a vertical spindle, which can be locked in one or other position, so that when one flue is open the other is shut.

The sectional area of the main flue is 7 feet by 4 feet 6 inches, that of the reserve 6 feet 3 inches by 4 fe et6 inches.

The chimney shaft is 150 feet in height above ground level and 7 feet 4 inches internal diameter at the top. It is lined to a height of 75 feet with firebricks, having an annular ven-

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tilated space between them and the chimney brickwork. This space is covered over at the top with projecting York stones built into the outer brickwork which slightly overhangs it to prevent dirt, etc., falling into the cavity; this projection is a few inches above the firebrick lining, to allow for expansion.

The foundations are octagonal in shape, 31 feet across the flats and 7 feet thick, with an area of 800 sq. ft., upon which the brickwork commences. This octagonal shape is carried up to a height of 34 feet above the concrete and 25 feet from the ground line, the last 3 feet consisting of eight granite blocks dowelled together and forming, with 3 feet of brick oversailing courses, a cornice from which starts the circular portion of the shaft. The shaft is built in red wire-cut bricks of ordinary pattern, and, with the exception of the base, without a scaffold. It is surmounted by an ornamental cap, the whole terminating in a massive cast-iron weathering ring in six sections, bolted together and rag bolted into the solid brickwork.

The latter is 1 in 40, with a smooth taper outside; eyes for scaling ladders are fixed on the north side.

The lightning conductor consists of a ring of copper carrying eight spikes, secured to the cast-iron weathering ring, and connected to an encircling ring at ground level by two copper tapes of 1½-inch by ⅜-inch section. Gun-metal holdfasts built into the brickwork give the necessary fixing for the tape, which is kinked in places to provide for expansion.

The ring at the base is provided with two earth plates, either of which may be disconnected for testing purposes. The object of the double tape is to secure a means of testing continuity. The shaft is calculated to withstand a wind pressure of 56 lbs. per sq. foot, without reckoning the binding properties of the mortar. The total load on the foundations is 1200 tons.

The mortar used consisted of blue lias lime, 1 to 2. The cooling pond lies a distance of one hundred yards from the central station, on the opposite side of the road; the supply of water is obtained from the roofs of buildings, supplemented by the water mains. The dimensions are 200 feet by 100 feet, with an average depth of 6 feet. The water is drawn from the corner nearest the station, through 15-inch cast-iron and spigot socket pipes, and returned at the opposite corner through pipes of the same dimensions. Valves placed in chambers constructed in the pond enable the supply to be cut off.

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The retaining walls are constructed of brickwork, surmounted by a blue brick coping, and backed up with earth; the bottom is of concrete 6 inches thick, laid in two layers, with a lining of Callendar's bitumen sheeting between to render it watertight; this sheeting is also carried up the sides in the brickwork.

The whole is rendered on the water side with $\frac{3}{4}$-inch Portland cement.

The pond is surrounded by an unclimbable iron fence.

The whole of the work has been carried out by civilian contractors, under the direction of the Commanding Royal Engineer, South Aldershot.

Mr. Arthur J. Mayne, A.M.I.E.E., is the chief electrical engineer on the civil staff for the scheme.

Supply Depot.

Owing to the recent great increase in the garrison of Aldershot and to the temporary nature of the supply buildings, it became necessary to provide a new supply depot of increased accommodation which should embrace all the most recent improvements in the supply of bread and meat to the troops.

The depot as now erected includes the following buildings:—

(*a*) Abattoir. (*b*) Cattle lairs. (*c*) Bakery and bread store. (*d*) Offices and guard-room. (*e*) Shops and stores. (*f*) Barrack block. (*g*) Water tower. (*h*) Forage barn.

Other works that will shortly be undertaken are:—

(*i*) Goods shed and cattle-platform. (*j*) Railway and sidings. (*k*) Cattle inspection shelter. (*l*) Coal and wood sheds.

Tramways are provided within the depôt for the carriage of flour and coal.

(*a*) *Abattoir.*—The general arrangement of this building has been based on the design of similar structures at the foreign animals wharf, Mode Wheel slaughter house, Manchester and elsewhere, and certain improvements on those designs have been effected.

The external dimensions of the building are 181 feet by 62 feet. It is divided into six sections, as follows, from end to end: first, ablution rooms, stores, etc.; then cartway; then pounds; then slaughter house; then cooling room; and lastly, issuing room and office. The dimensions of the issuing room

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are 72 feet by 60 feet; of the cooling room 36 feet by 60 feet; and of the slaughter house 20 feet by 60 feet.

Ten bullocks can be slaughtered at once in the abattoir, and for a full garrison of 30,000, 60 bullocks would be slaughtered daily. The cooling room will accommodate 50 bullocks in halves or 160 sheep; the issuing room 50 bullocks in quarters or 320 sheep. The issuing room, cooling room and slaughter house are all paved with granolithic concrete, and the walls are given a high dado of glazed blue and white bricks. Above the dado the walls are coated with Blundell's petrifying liquid. The junction of the two roofs is supported on rolled steel stanchions. The lantern of fixed wood louvres and Mellowes' glazing gives light and ventilation in addition to the windows and louvres in the walls.

Perhaps the most interesting feature in the building is the system of overhead trolley ways, fixed by Messrs. Herbert Morris and Bastert, of the Empress Works, Loughborough. There are 150 trolleys running on these tracks which, when fully loaded, can be passed from one end of the building to the other across the various points and crossings with the greatest of ease. Hoists and stretcher bars are also provided for loading the trolleys, and automatic self-registering weighing machines on each of the five main tracks.

For cooling and issuing, the meat remains suspended from these trolleys.

(*b*) *Cattle and sheep lairs.*—The beasts are turned into these lairs generally one or two days before being slaughtered. The lairs are connectod with the abattoir by a paved roadway strongly fenced.

They are of an irregular shape; the cattle lair of internal dimensions 98 by 61 feet; the sheep lair 40 by 30 feet, the accommodation provided being for 112 bullocks and 100 sheep. The bullocks are stalled in blocks 9 feet 4 inches wide with a water-trough down one side and a feeding passage between two troughs. They can either be tethered down to the bars at the foot of the trough or left loose in each block.

The floor is of granolithic concrete; the walls pointed and covered with Blundell's petrifying liquid. Ventilation and light are given by means of a lantern and wooden louvred windows.

Smaller pens are provided for the accommodation of the sheep.

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Forage is brought in by a gangway running along one end of the building.

(*c*) *Bakery and bread store.*—These are three-storied buildings connected together by a bridge and a covered way. In connection with the designs the arrangements in force at Messrs. Nevill's Bakery at Herne Hill and that of Messrs. Fuller, Church Lane, Hammersmith, were studied.

Nine 2-decked draw-plate ovens will be used in the bakery; eight of Messrs. Werner Pfleiderer Perkins and Company's telescocar pattern and one "Priton" oven by David Thomson, Slateford Road, Edinburgh.

Each oven, including fire-box, occupies a space of about 16 by 7 feet over all.

The Perkins oven bakes two sets of 190 2-lb. loaves in 55 minutes; the Priton, two sets of 152 2-lb. loaves in 45 minutes.

In both ovens heat is maintained by superheated steam in sealed pipes.

Thermometers, time-markers, and speaking tubes from bake-house to stoke-hole are supplied by the manufacturers.

The bakery is a building 270 feet long and 75 feet broad at its broadest dimension on the ground floor. The bakehouse is a room 100 feet by 45 feet into which the draw-plates of the ovens are drawn out. The walls are lined throughout with Candy's glazed bricks. The stoke-holes and mouths of the ovens are under a roof separate from the main building. The consumption of fuel is about 560 lbs. of coke to 2000 2-lb. loaves and 18,000 of these loaves may be required daily, involving a consumption of about 2 tons of fuel. There is storage in the bunkers for 17 tons of coke. The furnaces are connected together by a longitudinal flue which communicates by means of a central transverse flue with the chimney shaft about 60 feet high.

Immediately above the bake-house and of similar dimensions is the sponging and doughing-room, where by means of Messrs. Perkins' patent machinery, which obviates all handling in kneading, the flour and yeast are mixed, and the dough prepared. The unbaked loaves when ready are passed down into the bake-house below through two trap-doors.

The kneading and mixing machinery is as follows:—

Two patent universal kneading and mixing machines of 840 lbs. capacity, with hand-tilting arrangements.

Two "spiral brush" sifting machines, with striking gear and

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substantial wooden lids to kneading troughs and wrought-iron balancing tackle, and canvas shoot to connect with sifters.

Three patent water-gauging and tempering tanks, each of 60 gallons capacity, fitted with sliding scale and thermometer.

One patent high-pressure heating apparatus, with 160-gallon high-pressure hot-water storage tank, and two 500-gallon cold-water storage cisterns, with connections for supplying hot and cold water to gauging and tempering tanks.

The machinery in the above is actuated from shafting driven by a 25 B.H.P. Bushbury multipolar totally enclosed motor, built by the Electric Construction Company, working at 630 revolutions per minute; the current being supplied from the central electric station. The same motor will also work a sack-hoist for the flour store above the sponging and doughing room, and a sack-cleaning machine.

The remaining rooms on the ground floor of the bakery are: master baker's office, shifting-room, drying-room, canteen, waiting room, and a spacious dining-room, 50 by 41 feet, with a kitchen at the end of the building. In the basement is a boiler-house for the heating system, and a beer cellar and master baker's store.

On the first floor adjoining the sponging and doughing-room, are stores for potatoes, "cones," yeast and cases, and a brew-house 23 by 19 feet with four 40-gallon coppers for instructional purposes.

Ablution rooms and latrines are provided, separated from the main building by a covered way.

Bread Store.—This building, as has been noted, is connected with the bakery. On the ground floor there are the following rooms: bread store 81 by 30 feet, where the newly-baked bread is arranged on trays. It is stacked on these in four tiers and provision is made for 22,400 2-lb. loaves or 44,800 rations. Adjoining the bread store is a room for hospital supplies 30 by 17 feet, and next to this room a field-column equipment store of dimensions 40 by 30 feet with a mezzanine floor 20 by 8 feet for the storage of tents and tarpaulins.

Above the bread store on the first floor is a field column equipment store, 100 feet by 30 feet, for the storage of heavy articles of equipment; and above this again on the second floor, a flour store of the same dimensions. Rolled steel stanchions and joists are used for the floors and their support.

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The stanchions are encased with expanded metal sheeting and plastered with P.C.C. fireproof casing. The flooring is wood block set in bituminous composition on concrete; the floor of the bakehouse is of granolithic concrete. Special ventilating shafts are carried into the bake-house from the lantern.

(*d*) *Offices and guard-room.*—This building provides accommodation for the officer in charge of the supply depot and for a warrant officer, a guard-room, a store, and offices for a chief clerk and two junior clerks. Also water-closets and lavatories.

(*e*) *The shops and stores* form a building 170 feet long by 20 feet broad, in which the following are comprised:—(i) a retail bread store, (ii) an office, (iii) a retail butcher's shop, (iv) a carpenter's shop, (v) a lumber store, (vi) a shed for six travelling ovens, 54 feet long, (vii) a 4-stall stable. A store for mineral oil is also provided.

(*f*) *The barrack block* is a single storied building 68 by 25 feet and gives accommodation for a N.C.O. and 20 men.

(*g*) *The water tower* supplies a reserve of water in case of failure in the mains. It is a wrought-iron cylinder of $\frac{1}{4}$ inch plate 16 feet in height and of 16 feet diameter holding 3215 cubic feet or 20,000 gallons of water. It is supported on hexagonal framing 32 feet high. The design is an interesting example of how light framing may be consistent with stability.

(*h*) *The forage barn* is built for the service of the cattle lairs and is 45 by 20 by 12 feet internal dimensions, to hold about 24 tons of hay.

The goods shed will be for the unloading of flour, coal, and purchased meat. From the cattle platform adjacent to it cattle will be driven down a ramp straight into the lairs. The cattle inspection shelter will be for the veterinary inspection of the beasts as they arrive at the depot and can be used for segregation if necessary, or as an extension of the existing lairs.

DISCUSSION.

Mr. W. Weaver: I have read through the paper, and am struck by the care and attention bestowed upon it. The advance of Aldershot in recent years has been remarkably rapid. I see that the price of gas is 2*s.* 10*d.* per thousand cubic feet, which

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is very satisfactory from the consumer's point of view; there are very few places where the price of gas is lower than that. I do not quite follow the figures given in respect to the refuse destructor. As far as I can make out there are two cells, and to get through the work Mr. Dennis puts upon them, each must deal with 10 tons a day—a very high average. There are 3 tons of clinker a day, which is said to be used in the formation of bacteria beds. It seems to me the bacteria beds could not possibly absorb anything like the clinker refuse obtained from the cells. In fact, it must be only a small portion of it. I see that Mr. Dennis is in the interesting stage of constructing stables and depot, and is making provision for two steam rollers. If he would permit me I would suggest that he should make a pit under one of the roller sheds, for repairs, as it obviates the necessity of the men having to lie on their backs, and enables them to do their work better, and to earn their money. I observe that some portion of the electricity is supplied on the Rochdale penny-in-the-slot system. I should have thought that the shilling-in-the-slot would have been better, as when the light is being used a domestic will have to be employed constantly in dropping pennies into the meter. The figures given with regard to incandescent public lighting—that the cost is 4 per cent. more than the ordinary gas-burners—is not borne out by my own experience. In Kensington the main thoroughfares are lighted by electric arc lamps, the secondary roads by incandescent gas, and the side streets by ordinary gas-burners. My experience is that we obtain much more light at about the price the lamps were costing before the incandescent mantle was introduced. I have much pleasure in proposing a vote of thanks to Mr. Dennis for his paper.

Mr. J. LEMON: I have great pleasure in seconding the vote of thanks. With reference to the water supply, it is said to be ample in quantity, and that I believe to be the fact; but I am rather surprised the water company do not take some steps to soften it. It is not a very desirable thing to supply the public with a water of 16·8° of hardness. I do not know what effect it has upon the boilers in Aldershot, but I should think not a very desirable one. In reference to the capacity of the bacteria beds, Mr. Dennis says, "The permanent diminution in the holding capacity is not appreciable even in the bed that has been in continuous work for three years." Then a little further on, he

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gives the answer to it, because he says, "the surface depth to about 10 inches of the primary beds, is delved over once a fortnight, and the deposit on the top near the inlet is raked off and burnt in the destructor. The total accumulation thus removed amounts to an average of five barrows a day for the whole of the primary beds. The secondary beds are harrowed once a week. The labour required for this necessary work is two men constantly employed." I think it is the experience of every one who has to do with these bacteria beds that it is only a question of time when they will silt up if some steps are not taken to arrest, by sedimentation or other means, the matter in suspension. That is what would happen in Aldershot if steps were not taken constantly to remove the deposit from the beds. As the cost of doing that is at the very least 100*l.* a year, which represents a capital of 2000*l.*, I suggest to the Aldershot District Council, that the money could be profitably employed in constructing tanks to arrest the matter in suspension, and give the beds a fair chance.

Mr. A. D. GREATOREX: I should like to refer to the remarks made by Mr. Lemon as to the silting up of the bacteria beds. My experience at West Bromwich is that the beds have silted up to the loss of capacity stated in my paper read a fortnight ago.* The detritus tanks I am placing on the high level will deal with 400,000 gallons of sewage, and the cost of those tanks is just under 2000*l.* So you could at Aldershot for a sum of 2000*l.* put down tanks which would deal with more than one-half the daily flow. I feel sure after my experience of four or five years that beds constructed like these will silt up. Although the top deposit is taken off, and the material is raked over to a depth of 10 inches, a great deal of mineral matter will get down to the beds and they will lose in capacity. I therefore strongly recommend the Aldershot Council to adopt detritus tanks in order to preserve the capacity of the beds. I quite agree with Mr. Dennis in his assertion that neither distributors nor sprinklers are necessary, and also that the disposal of a town's sewage cannot be left to automatic machines. I think it is absolutety necessary that the working of beds of this character should be looked after by manual labour, and that the man in charge should be rather better than an ordinary labourer if the works are to be properly and successfully worked. I am

* See p. 32.

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pleased Mr. Dennis has made these two statements, because they confirm my experience. I should like to know the total cost of the beds. I notice in connection with the electric lighting works that although the installation was opened only last May, Mr. Dennis states the revenue is sufficient to cover all working expenses. I take it that only means actual working expenses: the revenue has not been sufficient to provide anything for interest on or repayment of capital. Even if the revenue has been sufficient to cover working expenses, the installation must have done remarkably well. The charges for the supply of current appear to be rather high; but still I have no doubt as more customers take the current the Aldershot Council will see the wisdom of reducing the price, so long as they keep within the point of paying their way. As regards street-lighting, I think it worth while for the Council to study one of the latest developments in street lighting, viz. the Nernst lamp. It is much cheaper than arc lighting. If you go in for arc lighting, it has the effect of making the main thoroughfares brilliantly light, and the side streets almost dark; whereas with the Nernst lamp you can get a very good light in all the streets at less cost.

Professor HENRY ROBINSON: What is the population whose sewage is drained to the outfall? The paper speaks of a dry-weather flow of 600,000 gallons, but does not give the population.

Mr. DENNIS: The estimated civil population is 18,000.

Professor ROBINSON: I quite agree with what has been said as to the necessity of intercepting inorganic matter in treating sewage biologically. I have had a great deal to do with this branch of work, and in spite of all you can do in intercepting road detritus, there is a certain amount of inorganic matter and fibrous substances which might get into the beds. It is therefore very important to those who have to design bacteria beds that they should take pains to remove whatever cannot be dealt with by the bacteria. I have lately designed beds with a provision for arresting such matters, as I know perfectly well that some inorganic matter may get into the beds in the course of years, and find its way into the interstices of the beds, and it will be necessary from time to time to wash it away.

Mr. W. BROOKE: I note that the dry-weather flow of sewage works out at 33 gallons per head per day. Perhaps Mr. Dennis will tell us the quantity of water per head supplied

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by the water company. With respect to the isolation hospital, I notice that the cost works out at 273*l.* per head. This is a very unsatisfactory way of working out the cost of a hospital. I have been gathering information on this subject lately, and find that the cost varies from 100*l.* in one case to 500*l.* per head. The cost of the site makes a very material difference in the cost of carrying out a hospital. I should like Mr. Dennis to give us the cost of the isolation hospital wards and administration block at so much per foot cube. My council wanted me to carry out a hospital building at a cost of 100*l.* a bed, but I pointed out that such a restriction was absurd, as the mean cost of similar institutions was 250*l.* per bed.

Mr. W. HARPUR: I should like to know the cause for the statement that "the quality of the effluent has been impaired by the Local Government Board's requirement to pass it over land before discharging into the Blackwater." It seems to me there must be some peculiarity about the soil over which it passed to cause such an effect upon the effluent after leaving the beds. There must be some particular cause for this, otherwise it is contrary to all experience up to the present time.

Mr. R. W. CASS: The rapidity with which bacteria beds choke in the interior, will probably be proportionate to the amount of inorganic matter in the sewage, which inorganic matter the microbes cannot assimilate. Especially does this apply to inorganic matter in solution, such, for example, as iron in solution, which would precipitate ferric oxide in the interior of the beds very rapidly. In the West Bromwich sewage there may be a large proportion of this metal in solution, which would account for the results; whereas in Aldershot, which is a purely domestic sewage, the results would naturally be quite different. In some cases there is as much as 15 per cent. of iron in the sewage. Each case should be considered separately and determined according to the chemical and physical nature of the sewage. If this was done a great many mistakes and apparent contradictions would be avoided.

Mr. A. H. CAMPBELL: I notice Mr. Dennis states that the sewerage of the town is on the separate system, and further on, that the cost of private street works at per foot frontage is between 10*s.* and 12*s.* per foot. I presume Mr. Dennis means, that is the cost of connection of the gullies to the separate drains and not the cost of laying the drains themselves. Speaking of

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10*s.* or 12*s.* per foot frontage, I notice that most of the roads are made up with local gravel. I do not think local gravel a permanent pavement to be taken over by the local authority. It seems to me if flints could be obtained, the cost need not be largely increased. I should like to mention that in the district I represent we have spent in three years 40,000*l.* in the making up of private streets, the work being done by direct labour with Kentish flints and granite kerbs as channels, and with granolithic—in situ—foot pavements at a cost of between 8*s.* 6*d.* and 9*s.* 10*d.* per foot of frontage. That price, I think, holds the record for districts around London. I should like to ask whether the private street works are undertaken by direct labour or contracted for? On the question of the refuse destructor, I notice Mr. Dennis gives the price of labour—which is very important—at 1*s.* 2*d.* per ton. That appears excessively moderate, and I do not think it can be rivalled for gross cost per ton. Probably the installation of the Meldrum destructor with feeding direct into the cell at a low level, conduces to that low rate. I should like to ask a further question with respect to the electric lighting. He states that the first six months' working was carried out by Messrs. Parker under contract on the minimum unit guarantee principle. If Mr. Dennis could give us information as to what that principle means in its application it would be interesting information.

Mr. J. A. CROWTHER: I should like to ask whether the refuse has been actually weighed, or is this amount estimated? If it has been actually weighed, I think the price of 1*s.* 2*d.* per ton is a very reasonable one; but my experience is that the cost of burning refuse varies throughout every month of the year. It depends entirely upon the character of the refuse. I have burned it from 11½*d.* up to 1*s.* 4½*d.* per ton. In August of this year the cost for burning was 1*s.* 3¾*d.*; in July it was 1*s.* 2⅝*d.*; in June it was 1*s.* 4¼*d.* This is accounted for to a great extent by a certain proportion of garden refuse being put in it. Then we all know how people are practising economy all over the country, and are taking out all combustible matter from the ashes; and of course that increases the cost of burning. The reason I asked the question as to whether this has been actually weighed or not, is that some years ago I estimated a large quantity of refuse, and found the cost of burning it came out at about 9*d.* per ton. We put down a weigh-bridge and weighed

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the refuse, with the result that the price went up from this ridiculously small figure to 1*s.* 2*d.* per ton.

Mr. A. J. DICKINSON: With regard to sewer ventilation, I should like to ask Mr. Dennis whether he has altogether abandoned surface grids. I notice he has put up a large number of ventilating shafts. As regards the crop on the sewage farm, we are told it is a very poor soil. I am very much interested in this question of farm crops. I have on my own farm a crop of mangold wurzels averaging about 50 tons to the acre which will pay the whole cost of working together with interest on capital and repayment of loan. With regard to the main roads, I find from the paper there are six miles repaired with quartzite and local pit flints, and the remainder of the roads with broken gravel. I think gravel is a very costly material to put on a road of any kind whatever, even if you got it free, to say nothing of a cost of 2*s.* per yard. My experience is that granite is the most economical material. I should also like to ask the cost of the water tower spoken of in the paper.

Mr. E. WILLIS: I should like to ask what treatment is used at the electricity works to soften the feed water for boilers, as it is practically impossible to use water with 16·8 degrees of hardness without some softening process. Mr. Dennis speaks of the daily dry-weather flow of sewage as 600,000 gallons, but further on he states that the quantity of sewage pumped per day by the destructor is about 800,000 gallons, a difference of 200,000 gallons in the daily flow, which means that either storm water or surface water finds its way into the sewers. This points to an excessive amount of rain if the separate system is carried out in its entirety, or else that the sewers are leaky and that the subsoil water gets into them. With regard to the bacteria beds, I should like to ask whether the bottoms of the beds are undrained and laid to falls. Mr. Dennis speaks of some special arrangements which are being made for reducing the wear and tear of the fire-bars at the electricity supply works. Would he mention the method which is to be adopted?

Lieut.-Col. JONES, R.E.: For years I have been insisting that what we want are properly educated men to become managers of farms. We want, in short, men who understand the ins and outs of sewage treatment. It is a very large question, and I hope in the afternoon to have an opportunity of showing

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you the camp farm which has been under my management for the past seven years. The farm, which is one of the earliest illustrations of the application of sewage to land in England, was let for a time to a tenant who neglected the treatment of the sewage for economical views of farming, with the results that the farm went altogether wrong and its stored-up fertility was exhausted. Now, however, after seven years of restoration by the expenditure of a great deal of money by the War Department, it is beginning to be put right and produce a fair effluent, and heavy crops of grass and roots. I think the Aldershot town works have been conducted satisfactorily and most economically, with very thin contact beds and a destructor on the spot, serving the double purpose of consuming the sewage sludge and producing cheap clinkers as material for the contact beds.

The afternoon was occupied with an interesting round of visits to the town sewage works, the military clothing store, the camp farm at Ash Vale (where the engineer, Lt.-Col. Jones, acted as guide to the party), the abattoir, the electric lighting works, and the camp swimming baths. On returning to the town a visit was paid to the electricity works, where the Members were kindly entertained to afternoon tea.

Communicated Reply.

Mr. Dennis: With reference to the points raised in the discussion on the bacteria treatment of sewage, I am pleased to hear that Mr. Greatorex agrees with me in disapproval of the automatic feeding of the beds, and that skilled attention is required to be given to the working, but I cannot admit his and Mr. Lemon's statement that the expenditure on labour in attending to the surface of our beds is sufficient to defray the cost of a large detritus chamber which would do away with the labour now employed. This is tantamount to an admission that the bacteria beds are automatic, requiring little or no attention to the surface. Again, it would be necessary to cleanse the large detritus chambers suggested, which would absorb much of the expenditure assumed to be set aside for the repayment of the charges on capital. I think the fact stated in

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the paper must have been overlooked that two small detritus chambers are provided, and those are sufficient for the purpose required of them. Whatever might be done in the way of detritus tanks, I maintain attention and labour must be devoted to the surface of the primary and secondary beds. It is much more satisfactory and economical to remove the grit and the insoluble organic matter from the surface of the beds in preference to permitting it to remain and to be washed down to diminish their holding capacity. No horse labour is employed in the harrowing of the secondary beds. Gaugings of the sewage were made upon two of the primary beds on February 11 and 12, 1901, and upon the same two on subsequent dates. On September 25 and 26 of this year the gaugings indicated a falling off in the holding capacity of 345 gallons for primary beds of the size of 57 feet by 35 feet by 4 feet 6 inches deep of clinker. This result I attribute to the care and attention given to the surface of the material. The cost of the new primary beds including carriers, filling, etc. complete, works out at 3815*l.* per acre, and the secondary beds at 1276*l.* per acre. In reply to Mr. Weaver, it will be eighteen months before the whole of the secondary beds will have been completed, during which time it will not be necessary to look to other outlets for the clinker produced by the destructor. There are two cells only to the Meldrum destructor at the works which are fed from the front. The cells are worked one at a time on alternate weeks. The quantity of refuse mentioned in the paper is obtained from weight and not from measurement only. I agree with Mr. Crowther that the price per ton destroyed varies greatly according to the season, but the price stated, viz. 1*s.* 2*d.* per ton, is based upon a year's average. Mr. Willis considers there must be a great leakage of subsoil water into the sewers, because the average daily flow of sewage is 800,000 and the dry-weather flow 600,000 gallons. I do not think this is excessive, representing as it does a difference of about 11 gallons per head, whereas as explained in the paper, the whole of the rainfall collected on the back portion of all roofs of buildings and the back yards together with the entire surface water from a length of one-seventh of the mileage of roadways discharge the rainfall into the sewers. All new streets are done under contract. The cost per foot frontage given is inclusive of the cost of the laying of surface water drains in

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addition to the branch drains to gullies, where they do not already exist. Mr. Greatorex considers the charges for a supply of electricity somewhat high, but with a small undertaking the 6*d.* and 4*d.* charges are most reasonable. The average price obtained is 5*d.* per unit. The works costs are slightly below that figure and will still continue to decrease as the demand increases, affording a greater margin to be utilised in the repayments of the charges due to capital. Experiments are being made with the Nernst lamp for public lighting; it has not, however, been decided to adopt it as yet. Very few slot meters have been fixed, but of those which are being used the silver coin meter is the most favoured. The "maximum unit generated" principle referred to in the paper represents the minimum payment on the basis of 100,000 units used per annum at 3¾*d.* per unit, 1¾*d.* for the next 25,000 units, and 1*d.* per unit for all in excess; but the Council have the option of an alternative, namely, 10 per cent. on the actual cost of running the station during the time the works are under Messrs. Parker's control, which expires as at present arranged on March next. I am sorry that I cannot give Mr. Brooks the cost per foot cube of the various hospital buildings, my estimate having been made out from quantities prepared for the whole of the buildings. The angles in the walls of the wards are rounded and the rendering is finished at floor level to a pitch pine cavetted moulding. I beg to express to the large number of Members present at the meeting my thanks for the kind way they received the paper.

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EASTERN DISTRICT MEETING AT KING'S LYNN.

October 18, 1902.

Held at the Guildhall, King's Lynn.

T. H. YABBICOM, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Mayor (Mr. T. E. Bagge, J.P.) received the Members and offered them a hearty welcome.

The President returned thanks on behalf of the Association for the kind welcome they had received.

The Minutes of the last Eastern District Meeting were read, confirmed and signed.

Mr. J. W. Cockrill (Great Yarmouth) was unanimously re-elected Hon. District Secretary for the Eastern District.

The following paper was then read and discussed:—

FIVE YEARS' MUNICIPAL WORK IN KING'S LYNN.

BY HENRY JAMES WEAVER,
BOROUGH SURVEYOR AND WATER ENGINEER.

HISTORICAL.

KING'S LYNN is a Parliamentary and Municipal Borough, an important market town and seaport. The town stands on the right bank of the river Ouse, two miles south of the south-east extremity of the Wash. It is an important terminus of the Great Eastern, Great Northern, Midland, and Midland and Great Northern Joint Railways by which it has communication

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with all parts of the kingdom. The name occurs in Doomsday Book as Leen and Leena. The town at the time of the Norman Conquest was already a port with considerable customs and many salt works. It belonged then and had belonged previously to certain Bishops. It continued till the time of Henry VIII. to be under the jurisdiction of the Bishops of Norwich, and it was known during that period as "Lynn Episcopi" or Bishop's Lynn. It was early and long a great resort of Hollanders and Flemings and others from continental shores of the North Sea, and in the time of Richard I. it was much frequented by Jews and had a flourishing trade. Louis the Dauphin took it in 1216, King John retook it, chartered it and returned to it for the purpose of removing his treasures when they were endangered by France, and in leaving to cross the Wash was overtaken by the tide, losing all his baggage and very nearly his life. It was visited by Edward III. in 1430, and it had a mint at this period, and sent nineteen ships to the fleet against France. Henry VIII. renewed its charter and changed its name to Lynn Regis or King's Lynn. Since the granting of the Charter by King John it has had eighteen other charters during the reigns of Henry III., Edward I., II. and III., Henry V., Henry VIII., Edward VI., Mary, James I., Charles II., and George II. Lynn sent two members to Parliament from the time of Edward I. until the passing of the Redistribution of Seats Act in 1885, when the number was reduced to one.

Area, Population, Etc.

The tract of country to the west of the town and across the head of the Wash is an alluvial flat, but that to the east rises in gentle eminences. The town is about 1½ miles long and over half a mile broad, and has an area of 3061 acres, with a population of over 20,000. Extensive ruins of the old town wall, which encircled the land side of the town, still exist, and the south gate of it, a fine tower with a lofty archway for carriages and two smaller ones for pedestrians, is in excellent preservation.

Market and Market-Places.

The cattle and corn markets are held on Tuesdays, the former being chiefly for sheep, over 30,000 of which are sometimes penned on fair days. This market has an area of 5 acres.

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The corn hall, which stands on the Tuesday market, was erected in 1854 and has a stone front. The Tuesday market-place comprises an area of 3 acres, and had formerly an elegant market-cross. The Saturday market, which is at the southern end of High Street, serves for butchers and others.

Municipal and other Buildings.

The Guildhall, formerly the hall of the Trinity Guild, has a chequered front of flint and stone with Gothic windows, and includes under its roof, assembly room 87 feet long, 22 feet wide and 22 feet high, council chamber, committee rooms, mayor's apartments and a complete suite of offices for the Corporation officials, also rates office. The custom house on the Purfleet was erected in 1683: it occupies the site of a religious house which belonged to the Trinity Guild, and is a mixed Greek style of architecture with a curious pyramidal roof surmounted by a small open turret terminating with a pinnacle at a height of 90 feet.

The Stanley public library is in St. James's Road; it was erected in 1883 and was presented to the town by the late Earl of Derby, K.G.

The public baths on Common Staith Quay were erected in 1856, and constructed of brick, containing hot, cold, salt, fresh, shower and swimming baths.

The Corporation erected the technical school on London Road in 1893.

Docks and Fisheries.

In former years the space between the town and the open sea was obstructed by huge banks of mud and sand, formed by the rapid action of the tide over the bed of the river, and the passage to the harbour was by a narrow and intricate channel. These evils were however corrected by the construction of a direct channel 4 miles long, which was commenced in 1850, and has resulted in the gain of a large tract of land on the bank of the Ouse on the northern side of the town. A new dock, the Alexandra, constructed in 1867–9 at a cost of 80,000*l.*, contains a water area of 6¾ acres. An important addition to this was made in 1884, when the Bentinck Dock, 1000 feet long by 400 feet wide, was opened for traffic. The estate of the

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King's Lynn Dock and Railway Company covers an area of over 100 acres; and in addition to the docks already mentioned includes every convenience for the shipment and discharge of cargoes, together with a branch railway which connects the dock with the Great Eastern, the Midland and Great Northern, and London and North Western railways. The fisheries, which are the property of the Corporation, are carried on for shrimps, cockles, mussels and whelks, of which immense quantities are despatched to London and the chief towns in the Midland Counties.

King's Lynn Waterworks.

The Old Supply.—Prior to the new works being carried out, the old supply was drawn from the Gaywood river, which rises some 7 miles away at the village of Grimston, issuing from the chalk springs in the district. The question of an entirely new supply became imperative, as the result of an inspector of the Local Government Board tracing the cause of an outbreak of typhoid fever to the contaminated water supply. The Gaywood river is most liable to pollution from numerous causes, and unfortunately the Corporation are unable by legal measures to prevent it. In the last two miles of its course it passes through the village of Gaywood, and is bounded on the south side, for some distance, by allotments and cottage gardens, and it was considered almost impossible to purify this source of supply, although filtration and other means were considered.

The New Supply.—The new works, which were completed in 1899, were designed by Mr. E. J. Silcock, M.Inst.C.E., of Leeds, who was at the time Borough and Water Engineer of Lynn. The site selected was seven miles to the east of the borough, at the village of Gayton, and consists of two wells sunk in the hard chalk, 14 feet apart, centre to centre, each 6 feet 2 inches in diameter, and 100 feet deep, both being steined with concrete varying in thickness from 14 inches to 6 inches. At the bottom of the western well there are two headings, each 6 feet high and 4 feet wide; one was driven for a distance of 153 feet to the south and the other 213 feet to the north. At the bottom of eastern well, a third heading was driven to the east for a distance of 293 feet, and in this well a bore hole 8 inches in diameter was sunk to a depth of 63 feet. The bottoms of the wells are 32 feet above Ordnance Datum.

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The Engines and Pumps.—The plant is in duplicate and all parts interchangeable. It consists of two sets of boilers, engines and pumps, which were made to deliver respectively 1,000,000 gallons and 1,250,000 gallons of water per day through 6243 lineal yards of 15-inch rising main to the reservoir at Bawsey. The top water level at the reservoir is 108 feet above the level of the bottoms of the wells. The head due to friction in the rising main is 15 feet, so that the total head against the pumps is 123 feet. The engines are of the horizontal, compound, triple expansion type, and have lately been so arranged as to run coupled together, and work both sets of pumps. They are connected to each other by means of a substantial shaft carried on massive brackets, to which is attached a special coupling, by which the engines can be immediately disconnected and one set of plant stopped, allowing the other set to continue running. By this arrangement the speed of the engines is greatly reduced whilst running together, and, at the same time, an excellent stand-by is also ensured. Whilst running coupled together the speed of the engines is from 75 to 80 strokes per minute, but when running separately the normal speed is from 112 to 120 strokes per minute, and they are designed for a working boiler pressure of 140 lb. to the square inch. The pumps are of the 3-throw type, the barrels are of gun-metal, and all large pipes, which are 13 inches diameter, are composed of steel plate and galvanised. The strokes of the pumps are 2 feet 6 inches, and they are geared to make one stroke to six strokes of the engine.

The requirements of the contract were as follows :—

1. The engines to be capable of pumping 1,000,000 gallons of water from the wells at Gayton to the reservoir at Bawsey in twenty-three hours.

2. The engines to give an efficiency of one pump horse-power to every 21½ lb. steam consumed per hour.

3. The boilers to evaporate 9 lbs. of water per pound of coal.

The dimensions of the cylinders are as follows : high pressure 6½ inches, intermediate pressure 9¼ inches, and low pressure 12½ inches, with a 14-inch stroke.

The boilers are two in number and are of the locomotive type; they are multitubular, and of mild steel, with the exception of the fire-boxes which are of copper; they have been tested to double the working pressure, viz. 280 lbs.

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The rising main is 15 inches in diameter, through which the water is pumped for a distance of 6243 yards, to the covered service reservoir at Bawsey; the pipes are socket pipes 12 feet long and ¾-inch thick, the average weight of each being 13 cwt. 1 qr. Before being delivered on to the site they were subjected to a water test equal to 400 feet head, and are coated inside and out with Dr. Angus Smith's solution.

The Service Reservoir.—The subsoil consists of boulder clay. The walls are constructed of cement concrete composed of one part of cement, two parts of sand, and four parts of shingle. They vary in thickness from 5 feet at the base to 18 inches at the top, and are lined with 4½ inches of brickwork set in cement. Their height is 14 feet, and the top of the reservoir is 11 feet above the ground level. The floor is composed of cement concrete, 18 inches thick, and where it supports the columns carrying the roof it is 3 feet 6 inches thick. It is in the form of a series of inverted arches, springing from the base of the columns, and has a 4½-inch lining of brickwork set in cement. The roof is constructed of 4½-inch brickwork, in a series of arches, which are carried by cast-iron girders, 12 inches by 8 inches, and 12 feet long, of ¾-inch metal; outside the spandril the arches are filled in with cement concrete, and the whole covered with ½ inch of pitch asphalting. The drainage of the top of the reservoir is provided for by means of agricultural pipes laid in the grooves, and the whole covered with 12 inches of earth. The reservoir is well ventilated by means of four cast-iron ventilators 3 feet square by 4 feet 6 inches high. The reservoir is constructed in two equal parts and divided by an 18-inch wall for purposes of cleansing. The level of the top of this wall equals one-half of the capacity of the whole reservoir, when both halves are full of water, i.e. 500,000 gallons, leaving a similar capacity in the upper portion which is undivided, so that when the reservoir is full it contains 1,000,000 gallons. The internal dimensions of the reservoir are 140 feet by 100 feet.

An electrical indicator is fixed which indicates the depth of water in the reservoir to the driver in charge at the pumping station, and there is telephonic communication from the station to the Author's office where a log book is kept, showing the depth of water in the reservoir, also in the wells at 9 a.m., 1 p.m. and 5 p.m. daily, also the quantity of coal consumed during

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the pumping period of the day. The top water level of the reservoir is 139 feet above Ordnance Datum. The delivery main is 15 inches in diameter and consists of cast-iron socket-pipes similar in all respects to the rising main, and measures 6900 yards from the reservoir to the east gates of Lynn, from whence it flows through the various delivery mains. The rising and gravitation mains are fitted with sluice-valves at the lowest points, and air-valves are fixed at the summit of each hill. The whole of the above work was carried out at a cost of 30,761*l.*

The Deacon System of Waste-Water Detection.—The daily quantity of water supplied through the water-mains to the borough in 1898 amounted to 1,150,000 gallons, or 57½ gallons per head. Early in 1899 the Author strongly urged the Water-works Committee to adopt a complete system of waste-water detection, the enormous quantity pumped into the town at that time being such that the new supply was unable to keep it going. Thirteen 6-inch Deacon waste-detection meters were fixed, and the town divided into districts, each of which was governed by a meter; stopcocks were fixed on every service, and valves so arranged on the mains as to command each street and section of district. Two night and two day inspectors were appointed, the duty of the former being to sound at night each stopcock with a stethoscope, first with the stopcock open, and then with it closed, in order to ascertain and locate the leakage if any. These inspectors made a daily report to the day inspectors, who visited the houses reported, and took the necessary action to meet each case. The number of inspectors has now been reduced to one, who acts as night inspector, and in conjunction with the foreman of the waterworks department is sufficient to cope with the work of the waste-water department. The result of the working of the scheme has been that over 20 gallons per head per day have been saved, so that instead of an average of 57½ gallons per head, 37 gallons are now used, and the Author is convinced that although underground leakages are very few the latter amount can still be further reduced by from 7 to 10 gallons per head by the Waterworks Committee taking action and prosecuting persons for wilful waste; but beyond this it appears to be quite impossible to reduce it, as in a town similar to Lynn with sewers of very flat gradients, necessitating constant flushing, also fish-washing, cockle-boiling, water used by the docks and railway companies and breweries, an unusual amount must necessarily be consumed.

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Early in 1900 the Waterworks Committee decided to renew washers on all bib taps throughout the borough, at their own cost, and although this has put an enormous amount of work on the department, it has no doubt been a step in the right direction. All new fittings are tested at the Corporation depot, and those approved are stamped, and unless bearing the Corporation stamp none are allowed to be fixed. The Author uses a drilling and tapping machine, which does not necessitate the water being turned off whilst connecting a ferrule for a new supply; this he considers most useful as the inconvenience to consumers caused by turning off the water is avoided, and from a sanitary point its value cannot be over-estimated as there is not the slightest chance of any contaminated subsoil water, or sewage matter, finding its way into the water main, which it is impossible to avoid in the old-fashioned way of shutting off the water and tapping the main when empty.

Fire Brigade.

The Borough Fire Brigade numbers thirty, including the captain and first and second officers. The appliances are as follows: Steamer No. 1 supplied in 1899 by Messrs. Rose and Son, capable of delivering 450 gallons of water per minute; steamer No. 2 supplied in 1881 by Messrs. Merryweather and Son, capable of delivering 250 gallons per minute. A hose-tender supplied by Messrs. Bath and Son, of King's Lynn, which carries 2000 feet of hose, all necessary ladders, jumping sheets, life lines, pumps, stretchers, coal, etc. A fire escape which reaches 42 feet high. A manual engine and two hose-carts. The members of the brigade are chiefly artisans, many being employees of the Corporation. They are paid for attending all fires and drills. The fire call is by means of a buzzer fixed to one of the boilers at the Corporation Electricity Works. The contractor for horse hire and the captain of the brigade are in telephonic communication with the fire station and the police office.

The existing fire station is most inadequate and uncentral, and the question of providing a new one is under the consideration of the Council; the Author has prepared plans for a new station, which will include hose-tower, stables and all other conveniences.

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Stables, depot, and yard.—As will be observed from the accompanying plan the depot is conveniently designed; it has recently been rearranged and new buildings erected by the Author. It will also be seen that there is only one pair of gates to the yard, all the men and materials must pass the foreman's office in entering or leaving the yard. Near this office is a weighbridge over which everything passes, and is booked to its respective work by the storekeeper, who is constantly in attendance. The depot consists of thirteen single stalls for horses and one loose box, a serving room and harness room with loft over, containing a chaff cutter and corn crusher, which are driven by a 3 B.H.P. electric motor; foreman's and storekeeper's office, weighing machine, painter's, carpenter's, shoeing-smith's and mason's shops, cement testing room, waterworks shop and stores, tool, lime, cement and coal stores, steam-roller shed and shop, and shedding to accommodate thirty waggons and carts, together with a commodious stone and material yard at the rear, and the whole is completely enclosed by a high boundary wall, and lighted by electricity.

The Corporation also make all concrete slabs for footpaths, which cost about 2*s.* 6*d.* per square yard. This finds work under cover for men during wet days, and at the same time the slabs are made considerably cheaper than they can be bought and delivered at Lynn. They are in the following sizes: 3 feet by 2 feet, 2 feet 9 inches by 2 feet, 2 feet 6 inches by 2 feet, 2 feet 3 inches by 2 feet, and 2 feet by 2 feet by 2½ inches thick. They are composed of one part of cement to four of sea shingle and sand, and the facing, which is ¾-inch thick, is of three parts of granite chips to two parts of cement; they are made on the ground in wooden framing, and when nearly set are grooved on the face by means of a small wooden roller.

Roads and Pavements.

There are 20 miles of streets and roads under the jurisdiction of the Corporation; 16 miles of which are macadamized and the remainder paved with either granite cubes or cobbles. The streets are narrow and get but little sun, and the subsoil being of alluvial deposit, they require constant patching and attention, to keep the surfaces in good order, where they are macadamized, and the Author has proved 1½ inch granite to be the best size for this purpose, and 1¼ inch for coating. The old pavements were

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mostly paved with Caithness stone, but many of these have been renewed with concrete slabs. In 1896 a loan was sanctioned by the Local Government Board amounting to 17,689*l.* for repaving many of the streets and footways, but owing to the excavations for sewerage, electricity, water and gas operations this work has been delayed, to allow for settlement of the trenches.

Town Refuse.

King's Lynn is very fortunately situated regarding the disposal of its refuse. It is all carted to a yard outside the town on the south side, and is sold to farmers and others at 1*s.* per ton for manurial purposes; but it is probable that some difficulty will be experienced regarding its disposal in the future, as a large amount of excreta from the closet vaults and the old box closets is no longer mixed with it; owing to the extensive sanitary improvements in the abolition of these and the substitution of modern water-closets, it is now taken by the sewers.

Sanitary Improvements.

The health department has also been most active. During the last four years 1600 privies have been abolished and modern water-closets fixed. It is estimated that not more than thirty old cess-pits remain, and the next few months will, I hope, see the last of them removed. Courts, alleys and yards, with which old towns are unfortunately troubled, have received their share of attention and no less than 280 have during the above period been either repaved or redrained, and made sanitary.

Infectious Diseases and Small-Pox Hospitals.

The Infectious Diseases Hospital, part of which was built in 1888 and part in 1897, and caretaker's sitting and bed-room in 1902, is situated a quarter of a mile from the south gates and about 200 yards from the Hardwick main road.

The hospital is a red brick building having two separate wards, male and female, with a frontage of 77 feet 6 inches. It has bed accommodation for twelve patients. In the centre is the nurses' room, also a bathroom. The administration block, which consists of nurses' bedrooms, bedroom and sitting room for the resident caretakers, pantry, scullery, kitchen and wash-

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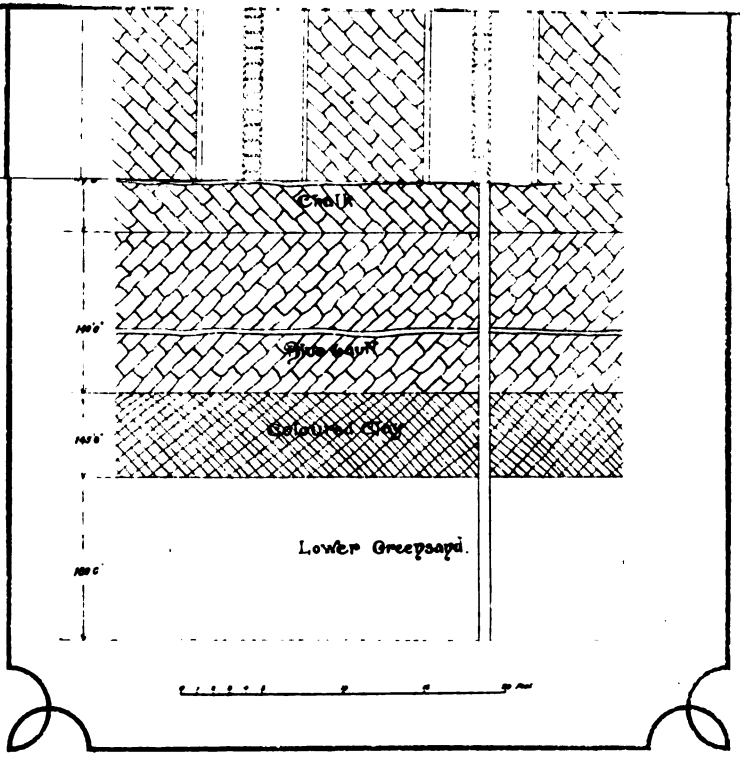

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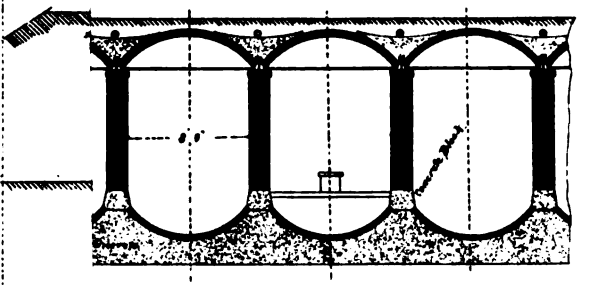

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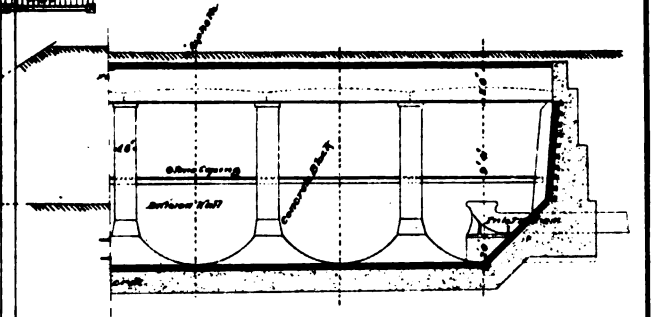

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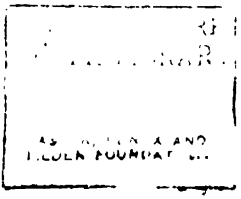

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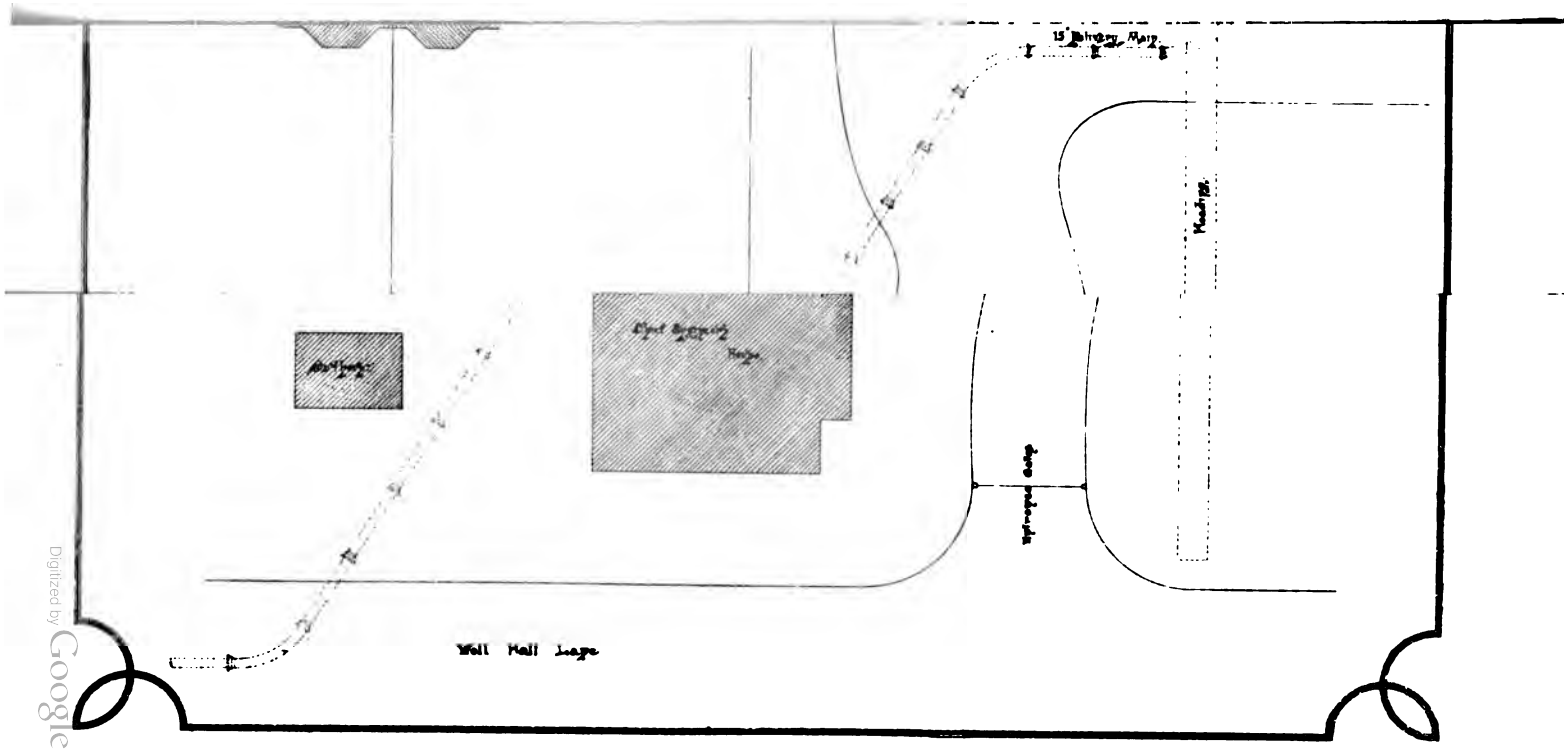

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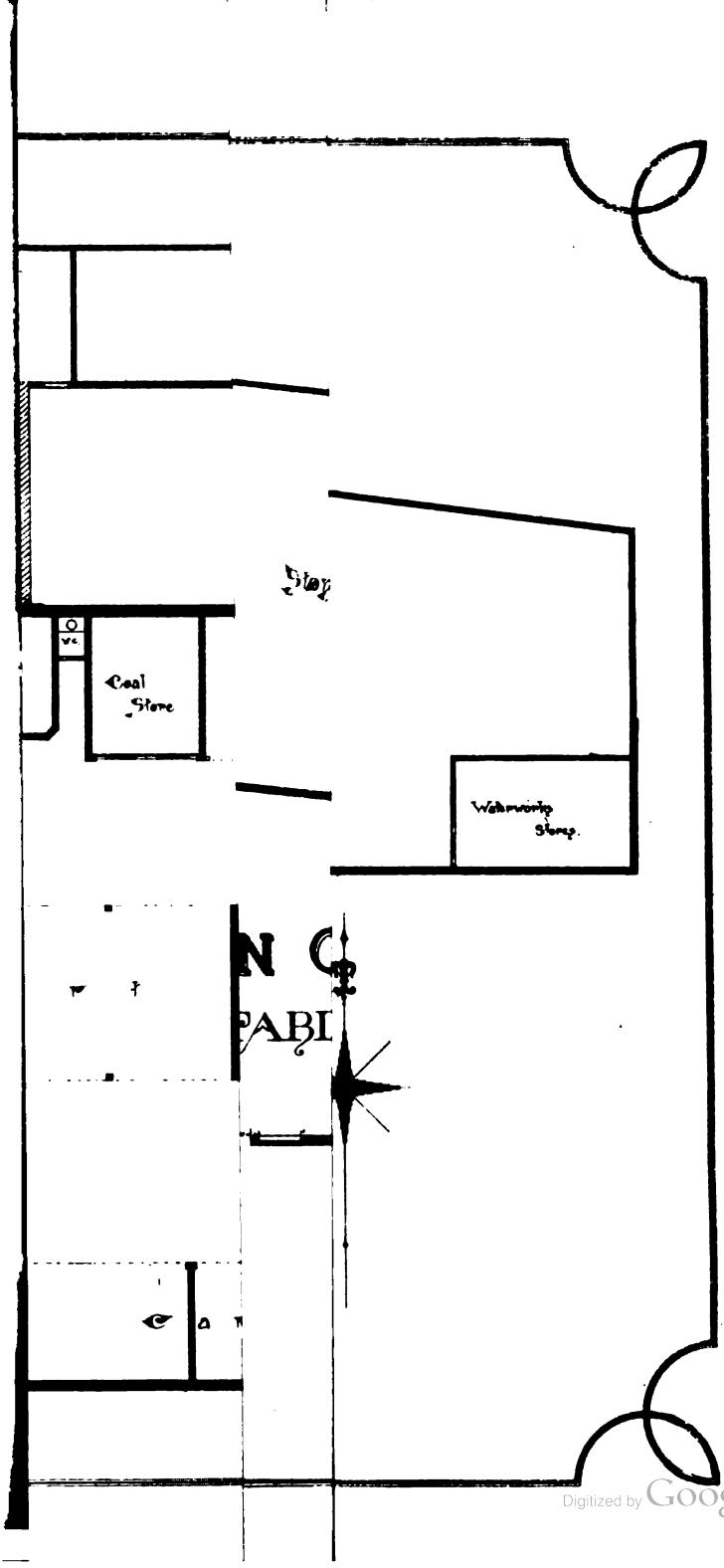

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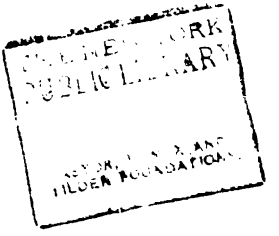

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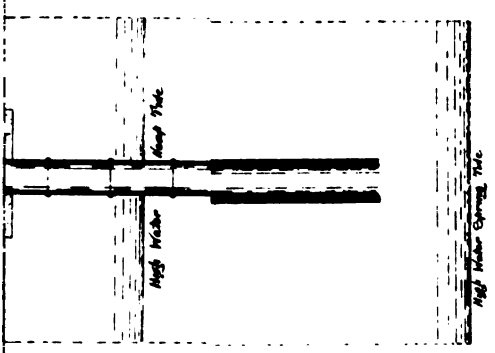

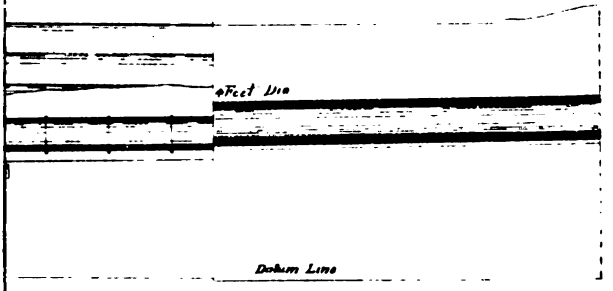

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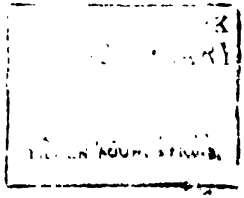

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house, is connected by means of a covered way. The wards are warmed by tortoise stoves, one in each ward, and under each bed is one of Kite's ventilators, and in the walls fresh-air inlets. The closets used are Moule's patent earth closets. The inclusive cost of the hospital amounts to 1200*l.*

The Small-Pox Hospital, is situated about a mile outside the town and half a mile from the Hardwick main road. It is bounded on the north, south and east by a deep and wide dyke, and on the west by a fence 7 feet high. It is a corrugated iron building, lined with matchboards, and with a frontage of 100 feet. Two 9-inch dwarf walls 1 foot 6 inches high run the entire length of the building and are built on a cement concrete foundation. Underneath the floor the whole site of the building is covered with cement concrete 6 inches thick. The walls of the building are lined throughout with two thicknesses of felt, one lining next to the matchboarding and the other next the corrugated iron, allowing air space between the matching and the iron. The floor-boards are tongued and grooved. The ventilation of the building is provided for, by having the galvanized iron ridge and the matchboard lining so fixed as to allow ventilation along the entire length of the roof. The top portions of the windows are hinged and are regulated by a cord. There are two main wards (male and female) each containing six beds, and two private single wards, so that fourteen beds are provided. Standing out from the front are two rooms for the day and night nurses, and from the rear of the building a commodious kitchen and scullery, pantries, linen-closets, etc., and a separate earth-closet is built for the administration block. Adjoining each main ward is a bathroom and an earth-closet. At the rear of the hospital are the laundry and drying rooms, the latter being fitted with a boiler and hot-water pipes. Hot water is provided for baths by boilers at the end of each ward. A caretaker and his wife reside on the premises, so that the hospital is ready to receive patients at a moment's notice. The total cost of the hospital and buildings amounts to about 800*l.*

The building was completed on April 13, 1902, and two days afterwards a case of small-pox occurred. The patient was immediately removed to the hospital, and on June 4 another case cropped up, this too was taken at once to the hospital, the result being, that there have been no further cases.

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Sewerage.

Previous to the new sewerage scheme which has just been completed, no system of sewerage could be said to have existed. There were very many outfalls to the river of various sizes and kinds of construction. The sewers were either of brick in bad condition, or were not laid in proper gradients and not sufficiently deep, they were badly ventilated and had very few manholes for inspection. In 1887 the ex-President of our Association, Mr. E. G. Mawbey, M. Inst. C.E., Borough Engineer of Leicester, who was at that time Borough and Water Engineer of King's Lynn, prepared and presented to the Corporation a scheme for sewering the town, but this was not proceeded with at the time, and on Mr. E. J. Silcock becoming Borough Surveyor of Lynn, he designed a scheme which has been carried out. It differed somewhat from Mr. Mawbey's scheme, inasmuch as it practically divided the borough into four drainage districts, each having a separate outfall, known as the South, Millfleet, Purfleet and North Districts, whereas Mr. Mawbey's scheme collected all these districts to one point, which was at St. Ann's Fort, North End, and from thence to the river by means of a large outfall sewer. Mr. Silcock, however, claimed that his scheme could be carried out at a less cost, and that such deep sewers would not be necessary, also that better gradients could be obtained. The combined system has been adopted, so that we have the one set of sewers carrying both surface water and sewage. Each of the four districts has a sufficient storage culvert to hold the sewage during tide-locked periods, and the culverts discharge through tidal gates in a confluent state into the river at low water. The total cost of the scheme amounts to 27,713*l.*

The Author has prepared a similar scheme for sewering South Lynn, a district which has grown considerably lately; the outfall will be into the river Ouse between the railway bridge and the freebridge at South Lynn, which is about one mile from the centre of the town, and the annexed drawing shows the construction of the proposed outfall. The storage culvert, to which a penstock is fixed, is of cast-iron flanged pipes where it crosses the foreshore, and the remainder is constructed of red brick with a blue brick invert. Hassal's patent jointed stoneware pipes will be used, and ventilation provided by means of shafts and manhole covers.

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KING'S LYNN ELECTRICITY WORKS.

By JOHN PILLING, M. Inst. E.E.,
Borough Electrical Engineer.

This short paper is in response to the request of the Borough Engineer of King's Lynn that a description of the electricity works of the King's Lynn Corporation should be read to the Municipal and County Engineers on their visit to the town. Perhaps the most interesting feature of the works is the fact that the plant consists of both gas and steam generators.

The Corporation obtained its provisional order in 1896, and in 1898 obtained the advice of Professor Henry Robinson who designed and laid down the initial gas-driven scheme which commenced to supply current in August 1899.

Professor Robinson first proposed a steam-driven scheme, but owing to the intended site for the generating station being substituted by another one, he altered his designs to a gas-driven plant, believing at the same time that there would be very little demand from private users, and that small gas generators would be capable of meeting the requirements.

The amount of the loan sanctioned for the initial scheme was 27,000*l.*, and the total expenditure has now increased by extensions to about 45,000*l.*

As the area supplied is a compact one the three-wire direct current system of supply was adopted with 400 volts across the outer conductors.

The generating station is on the site of the old waterworks where there is an abundant supply of water suitable for condensing and boiler feed purposes, and a railway siding for the delivery of fuel to the works.

The gas producer house is situated at some fifty yards distance from the engine room, and contains four Fielding and Platt's gas producers working on the Dowson principle, each designed to give off 13,000 cubic feet of gas per hour of a calorific

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value of 145 B.Th.U. per cubic foot. They are fitted with steam jet air injectors, the cast-iron pipe being laid in its passage to the underside of the fire-bars, between the fire-brick lining and the outer iron shell of the producer.

The producers are fed through hoppers from the top in the usual way, and are provided with cleaning out doors at the bottom. Two vertical boilers provide the steam for the air injectors.

Anthracite peas costing 24*s.* 6*d.* per ton delivered are used in the producers, and coke with screened ashes from the generators in the vertical boilers.

The gas on leaving the producer passes through a series of vertical cooling pipes on the top of which there is fitted a water spray. The gas then passes through a hydraulic box which prevents the gas returning to the producer, also two scrubbers, the first being filled with coke and sprayed with water, and the other consisting of two or three trays of sawdust. The gas can then be sent to a holder and on to the engines or direct through an auxiliary main to the engines.

The main gas-holder is of wrought iron 20 feet in diameter with a 10 feet lift and is supported on four cast-iron columns with wheels, chains, and an adjustable balance weight.

There are five gas engines working on the Otto principle with "hit-and-miss" governing. The engines run at 185 revolutions per minute and drive by belts 40-kw. dynamos. They are designed to give 65 B.H.P. when the number of explosions in the combustion chamber of the engine does not exceed two-thirds of the possible number. The engines are therefore large and massive for the required output, being capable of giving out about 100 B.H.P. for short periods. They have cast-iron single fly-wheels cast in one piece weighing over eight tons, running between the engine and an outer bearing, the fly-wheel also serving as belt pulley.

The cylinder, combustion chamber and exhaust valve seating are water jacketed and the water for the jackets is supplied by a two-inch centrifugal pump driven by a 2 H.P. electric motor.

The ignition is on the hot-tube method, the tubes and ignition valves being in duplicate to prevent stoppage of the engine in the event of a tube bursting. The further precaution is taken to heat one of the tubes by the producer gas and the other by town

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gas to avoid stoppage should the quality of the producer gas fall too low to heat the tubes sufficiently.

For starting the engines, Fielding's patent starter is used which operates as follows, viz. the crank is first set into position by hand gear and a charge of gas admitted to the combustion chamber, then compressed air is admitted from a storage cylinder which causes the charge in the engine to ignite at the ignition tube.

The compressed-air cylinder is pumped up by the gas engines themselves when slowing down after the gas has been shut off.

Each engine exhausts separately through three silencing boxes placed in series, into a brick pit filled with granite cubes.

The dynamos driven by the gas engines are of the ordinary two-pole type giving 88 amperes at 450 volts.

Soon after the works commenced to supply, the Corporation was obliged to consider the question of extensions owing to the great demand on the existing plant. Having found it impossible to prevent vibration and noise due to the working of the gas engines it was decided to carry out all extensions by means of steam plant. The subsoil of the site on which the station stands is of a very spongy character, and unsuitable for horizontal engines with heavy reciprocating parts, it being impossible to prevent vibration or rather oscillation of the ground. The Author advised the Corporation on the scheme of extensions, and the Borough Engineer has been responsible for the architectural work of the extension. The cost of the extensions at the generating station has been about 10,000*l*.

The boiler house plant consists of two Lancashire boilers 30 feet by 8 feet for a working pressure of 150 lb. per square inch. They are each fitted with Meldrum's forced draught furnaces for burning small coal. Slack coal is used at about 10*s*. per ton delivered. In each boiler flue tube five cross tubes are welded.

One 96-tube Green's economiser is installed, the scrapers being driven by a one H.P. electric motor through worm gearing.

There is also a Weir's feed pump capable of discharging 2400 gallons per hour against 150 lb. per square inch at 12 double strokes per minute. Provision is made for the fixing of a second pump when required.

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In addition to these there is a Gresham's injector capable of discharging 1200 gallons per hour against the boiler pressure. The feed pipes are arranged so that the water may be sent either through the economiser, or direct to the boiler, each boiler being provided with two feed valves. The feed water is drawn either from an iron tank in the boiler house, or from a well in the engine room which communicates with the pond outside, the water in the well being at the same level as that in the pond.

The storage tank is kept full by a portion of the discharge water from the condenser, the town water being also connected for emergency. Two Belliss-Laurence Scott steam dynamos are installed, one of 200 kw. and the other of 120 kw. running at 350 and 400 revolutions respectively.

The engines are worked condensing, and both exhaust into one Worthington jet condenser capable of condensing 10,000 lb. of steam per hour.

The Author receives many inquiries from engineers in various parts of the country with respect to the merits and demerits of gas and steam driving, and the paper would perhaps be considered incomplete if some reference to the actual results obtained from the two systems were not made.

During the twelve months ending March 31, 1901, gas plant only was in use, but during the year ending March 31, 1902, the current was almost wholly generated by steam plant. The sale of current during the former year was 245,009 and in the latter year 286,679 units, and the generating costs were as follows:—

—	Gas.			Steam.		
	Year ending 1901.			Year ending 1902.		
	£	s.	d.	Pence per unit.	£	s.	d.	Pence per unit.
Coal*	1004	15	3	·98	708	11	0	·59
Oil, waste, water and stores	119	9	9	·12	113	0	1	·09
Wages	636	10	11	·60	521	6	5	·44
Repairs of works and plant	233	5	0	·26	170	19	5	·14
	1994	0	11	1·96	1508	16	11	1·26

* The cost of coal in 1901 was increased by 100*l.*, owing to the enhanced prices ruling.

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For Dowson gas plants anthracite fuel (or coke, though it is as a rule not so suitable) must be used and the comparative cost of anthracite and suitable steam coal at any particular locality where the power is required, will determine whether the fuel costs would be lower if the power were produced by Dowson gas plant or by steam plant. Generally, if the price of anthracite peas in any district were over 1*l.* per ton, and steam coal could be secured at about 12*s.* it would be more economical to generate by steam. There are many other points, however, that tell against the gas engine in its present form which must not be overlooked when considering the pros and cons.

The Author believes that there is a great future for gas driving in electric generating stations, but it ought to be realised that before much headway can be made in this direction the gas must be produced from ordinary bituminous slack coal. The engines must be of large size corresponding to the powers of the large steam engines now existing in power stations, as the period of the multiplication of small generating sets has passed by. The engines will be direct coupled to the generators; they will not be governed on the "hit-and-miss" principle, but rather by varying the quality of the charge at each admission, and the ignition will probably have to be done by the electric spark owing to its greater certainty of action and greater ease of control.

Makers of gas engines are, of course, fully alive to the destructive action of the intense internal heat on the valves and other parts and its interference with the perfect internal performance of the engine, and are making strenuous efforts to overcome the difficulty.

It will be necessary for gas engine makers to consider the question of lubrication and the collection of the waste oil in order to bring the engines up to the perfection obtained in steam sets.

A storage battery is installed consisting of 225 chloride R type cells in glass boxes, having a capacity of about 400 ampere-hours when discharging in 10 hours.

The accumulator room is of two floors and the cells are arranged in four rows on each floor, mounted on the usual wooden bearers. An unusual method of regulation on the battery is adopted, the pressure being altered by "cutting" cells out or in on the negative side of the battery only, and altering the

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position of the middle wire connection to the battery from one well to another. The regulating cells on the negative end of the battery are arranged five cells per stop, and the middle wire cells three cells per stop.

The battery is charged across the feeders, and the end regulating cells are charged by a motor-generator which takes current at 400 volts and gives out current at 10 to 100 volts.

There is one disadvantage in this method of regulation, viz. when the discharge on the two sides of the battery is unequal it is impossible to adjust the middle wire regulator, so that the middle wire regulating cells each receive their proper amount of charge which leads to rapid deterioration of those cells.

The balancing of the load on the three-wire mains is done by the battery at the station end of the distributing system, in addition to which there are two motor-transformers fixed in the basement of the town hall on the opposite side of the town.

Five concentric two-wire feeders leave the station laid in Doulton conduits. The feeders as well as the distributors are insulated with impregnated jute and lead sheathed. The distributors are triple concentric, and armoured with two layers of steel tape, and chiefly laid direct in the ground with a covering of creasoted boards to serve as a protection. The polarity of the outside conductor of the main is reversed at intervals in order to make the connection of services easy, and the neutral wire of the cable is always the middle conductor, thus obviating the need of cutting down to the innermost conductor of the cable, except for three-wire services.

The balancing of the consumers on the two sides of the system needs very little attention, as by this reversal of polarity it is brought about almost automatically. The street lighting of the town is done entirely by electricity. At present there are eight Siemens open-type arc lamps, fourteen Davy enclosed arc lamps, ten Nernst lamps, and 450 lamps, each containing a pair of 16 candle-power incandescents.

The open type arc lamps are arranged four in series and the enclosed type two in series between the neutral and "outside" wires of the distributors. The two incandescent lamps in each lantern are wired in parallel, and usually each lantern is connected separately to the distributing mains, but in some cases as many as four or five are on one connection and controlled by one switch.

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In the wider streets the lamps are fixed on posts, but in the narrow streets they are fitted on wall brackets, or suspended across the streets by means of steel wire or wrought-iron arches.

The Electricity Committee supply, erect and maintain the lamps at the following inclusive charges per annum, viz.:—

	£	s.	d.
Each arc lamp	16	0	0
Each lamp containing a pair of 16 c.p. incandescents, or each Nernst lamp	3	10	0

The department carries out wiring work and the supply and fixing of motors for its customers for cash, but has not instituted any scheme for hiring out of motors or free wiring.

There are now some 360 consumers connected to the mains, or about 17,000 lamps of 8 candle-power (or equivalent) including over 100 H.P. in electric motors.

DISCUSSION.

Mr. E. BUCKHAM: I have pleasure in proposing a vote of thanks to the Author. I notice Mr. Weaver says that most of the sewers are laid in a blue alluvial deposit. I take it that there is considerable difficulty in constructing sewers in a soil of that nature, and I should like to hear from him what his arrangements were for overcoming the difficulty and to what extent he met with water, and how he dealt with it.

Mr. A. E. COLLINS: I am told in times past there used to be in Lynn a system of septic tanks to each house, with overflows to the sewers. If that is so, I should be glad to know the former practice in that respect.

Mr. E. J. SILCOCK: I should like to second the vote of thanks to Mr. Weaver for the paper he has prepared for our information. Water coming from such a source as described by the Author is bound to be pure, and the only question which can arise is that of hardness. I am speaking from memory but I believe the hardness is 15°. It is not an excessively hard water, it is much softer water than that derived from the London chalk; for some of the London water companies supply a water harder than 15°. I think the town is to be congratulated upon having obtained such a good and copious water supply at a cost

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of 30,000*l.*; for a population of 20,000 to get a supply of 1,000,000 gallons a day for a capital outlay of 30*s.* per head is a very cheap supply. We found in excavating for the sewer trenches that the subsoil varied greatly in character and in short distances. In the length of about 50 feet you might find two or three kinds of deposit. The whole of the ground in this neighbourhood has been deposited in fresh or salt water, and is made up of peat, silt and warp. In the old parts of the town you find a great deal of artificially made ground; it has been filled in and the surface has been raised; so you have to have all the trenches close timbered, and afterwards leave in the greater part of the timbering. The cost of timbering in all such works is naturally very great. We did not have any very great difficulty in keeping the sewers in position when once constructed, even though the bottom of the trench was so soft that when trodden upon, it moved up and down. When we had got the sewers in there did not appear to be any subsequent movement. In some places, we had to use brush work and heather to make foundations. There is no pumping necessary: it is all done by gravitation, and making use of the rise and fall of the tide. The range of tide is 25 feet spring tides, and 17 feet neap tides, and there are about six hours on each tide during which we can discharge the sewage into the river. The septic tanks referred to by Mr. Collins, were not actually septic tanks but decomposing chambers, and each house had one of those chambers. It was a brick structure 4 feet by 2 feet and the outlet was arranged with a plug dipping down into the sewage. The object of this was to form a trap between the sewer and the house. As a matter of fact it did undoubtedly form a septic tank, because you had septic action going on, and practically nothing but liquid came away from that chamber. I saw scores of them opened, and undoubtedly they had a great effect in liquefying the sewage.

Mr. COLLINS: Where were they situate—inside the house or outside?

Mr. SILCOCK: Sometimes in the house: generally outside.

Mr. WEAVER: All the surface water was conveyed into the tanks as well as the sewage.

The PRESIDENT: With regard to the water supply, I would like to ask in what way the houses are charged, and also whether the supply is constant day and night. The quantity of

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water mentioned as being supplied to the town is abnormally high, and even now that it has been reduced to 37 gallons a day it is very considerable. With reference to the paving slabs, I suppose we may take it that the sea shingle or gravel is the inexpensive, and the granite and sand the more expensive materials. In regard to macadam roads, Mr. Weaver says "he has proved 1½-inch granite to be the best size for this purpose, and 1¾ inches for coating." I do not know whether that is a misprint: but do not quite see how it follows. In a later paragraph he says, "In 1896 a loan amounting to 17,698*l.* was sanctioned by the Local Government Board for repaving many of the streets and footways; but owing to the excavations for sewerage, electricity, water and gas operations, this work has been delayed to allow for settlement of the trenches. I do not know whether Mr. Weaver may be an optimist and considers he has come to the end of excavations for these purposes: in that case I can assure him he has not. Then Mr. Weaver also expresses the fear that there will be some difficulty in the future in connection with the disposal of the town refuse, as a large amount of excreta from the closet vaults and the old box closets is no longer mixed with it. I should think it a matter of congratulation and not of alarm. Regarding the infectious diseases hospital, I should like to ask whether any provision has been made for a constant supply of hot water on the circulating or other system for the baths. Then I should like to have the ruling gradient of the intercepting sewer, and at what time before or after high water the discharge of sewage can be commenced. With regard to the electricity works, I see that the cost of the arc lamps is put down at 16*l.* per annum, and conclude that the price charged is only a matter of account between departments. It is a very reasonable sum; does it include the poles, fixing, wiring and so forth? What price per unit is charged to private consumers for lighting and for motive power?

Mr. WEAVER, in reply, said: With regard to the charge for water, we have lately arranged not to make a separate rate for this purpose, but to charge it in the general district rate. It comes out at about 8*d.* in the £. For trade purposes we charge by meter at 7*d.* per thousand gallons. As to the slab making, we get the shingle cheaply, the cost being but 4*s.* per ton delivered. Coming to the question of paving, the President

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has suggested that I am somewhat optimistic in thinking that excavation will cease, now that the sewerage, water, electricity and other works are completed. I can only say that our roads and footpaths have been terribly torn about during the last three or four years. When we consider that the whole town has been re-sewered, and the majority of the old water mains taken out and new ones substituted, a large number of the gas service pipes removed, and the pavements taken up for laying the electric cable, you will agree with me that our roads and footways have been, to say the least, somewhat roughly handled and that a slight rest is beneficial, in fact absolutely necessary. And I hardly think it optimistic to venture to hope that for the next few years even less than the normal amount of excavations will take place in our streets. There is no doubt that I shall begin the work of paving in earnest next year, but owing to the above works, and the nature of the subsoil, it would have been unwise to have to commenced this work before. On the question of water supply to the small-pox hospital, a constant supply of hot water has been provided, a well having been sunk near the buildings, from which water is pumped to a large tank at such an elevation as to gravitate to all parts of the buildings, and two separate small boilers keep each ward constantly supplied with hot water.

Mr. J. PILLING, in reply, said: The price charged for the public arc lamps in the borough is 16*l.* per annum. They only burn from dusk to 10.30 p.m., after which time a pair of 16 candle-power incandescent lamps are switched on. The President was right in thinking that 16*l.* is a reasonable sum, and is really an adjustment between the two committees. The charge to private consumers is 5*d.* per unit, and to those on whose premises the light is used after 8 o'clock 4¾*d.* per unit. The price for power is 3*d.* per unit for the first hour and after that 1¼*d.* per unit.

The Members were then afforded an opportunity of inspecting, under the guidance of Mr. J. W. Woolstencroft, the town regalia, plate and ancient records; after which luncheon was served in the Town Hall, the Mayor presiding.

The afternoon was devoted to visits to the Fire Brigade Station, the Town Depot, the electricity works, and the waterworks at Gayton.

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MIDLAND DISTRICT MEETING AT BIRMINGHAM.

January 31, 1903.

Held in the Council Chamber, Birmingham.

T. H. YABBICOM, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Members were received by the Lord Mayor (Alderman H. Rogers), who offered them a hearty welcome.

The President thanked the Lord Mayor for the kind welcome extended to the Association.

The Minutes of the last Midland District Meeting were read, confirmed and signed.

Mr. J. S. Pickering (Nuneaton), was unanimously re-elected as the Honorary District Secretary.

The following papers were then read and discussed :—

SEWER VENTILATION.

BY T. CAINK, ASSOC. M. INST. C.E., CITY ENGINEER, WORCESTER.

IF there is one subject more than another which the Association is entitled to an apology for having imposed upon it, it is that of sewer ventilation. So much has been said and written about it, and so often, that the Author is afraid the subject must have become almost as nauseous as the odours which give rise to it, and but that our District Secretary assured the Author that a

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paper upon it would be acceptable to the Association, he would have hesitated before submitting it. At the same time it can scarcely be said that the problem, which has sorely vexed sanitary engineers for the past forty years, is as yet satisfactorily solved. No more conclusive evidence of this could be needed than the paper on the subject recently read by Dr. Dearden at the Manchester Congress of the Sanitary Institute. The Author is not quite sure what conclusion was intended to be drawn from that paper, but it seemed to him that the view held by the Doctor was, that sewer ventilation by the old method of surface gratings was bad enough, but that every improvement upon it was worse. If that is so, then certainly we have not reached the end of the controversy.

The purpose of the Author is to submit to the Association for discussion a certain direct issue, viz. :—whether, having regard to all the circumstances, the object sought to be attained in the ventilation of sewers is best secured by the ingress and egress of as *great* or as *little* a volume of air as possible, consistently, in both cases, with avoiding any appreciable pressure being put upon the water-seals of the private drains.

Before, however, discussing that point there is the preliminary question to consider, viz. :—whether it is necessary to ventilate sewers at all.

We all know there are towns where no special provision at all is made for the ventilation of the sewers, yet the inhabitants of those towns survive and apparently present as clean a bill of health as towns in which the ventilation of the sewers is amply provided for.

Still it is obvious that the foul air of the sewers, to say nothing of the gases which arise from the decomposition of the sewage, must be displaced and driven somewhere by every increase of volume of the liquid flowing therein, apart from other causes, and to say the least, it does not seem satisfactory not to know where such air is driven. If the sewer is constructed with watertight joints and impervious materials, it must be sent through the water-seals of the drains connected therewith, which are provided for the express purpose of preventing the passage of such air. A modern well-made waterproof needs ventilating, and it is poor consolation to the man who wears a badly made or a too well worn coat, to point out to him the advantage it possesses of needing no other kind of ventilation.

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As the Author assumes that it is the effort of every engineer to construct his sewers with impervious material and watertight joints, he will, therefore, also assume that provision for the ventilation of sewers is necessary.

The Author was first troubled with this question some twenty years ago when he took charge of a district in which an entirely new system of sewers had just been laid. A loan had been sanctioned by the Local Government Board for the scheme, which was designed upon the lines advocated and insisted upon by the Board.

For a number of years previously, the question had been a burning one, owing to the frequent complaints received by local authorities all over the country of the foul odours arising from the surface gratings which were then almost universally adopted.

The late Sir R. Rawlinson was at that time Chief Engineering Adviser to the Local Government Board, and he advised that the remedy was to be found in increasing the number of ventilators, provided the sewers were properly constructed, with sufficient falls, and were periodically flushed so as to prevent the accumulation of deposit in them.

The scheme to which the Author has referred was designed by the late Mr. Pritchard, a Past President of the Association, and well fulfilled all the conditions laid down by Sir R. Rawlinson as necessary to ensure freedom from foul odours issuing from the ventilating gratings. The sewers were all constructed of stoneware pipes, with good gradients, and were flushed weekly.

The work of construction was superintended by a present Member of the Association, whose name would be a sufficient guarantee that it was thoroughly well executed. Indeed, the Author can scarcely conceive a scheme better adapted to put the method advocated by the Local Government Board upon its trial than the one alluded to, and that is his reason for adverting to it. In less than twelve months complaints of the foul smells from some of the ventilators came in. They were staved off for a time in one way or another, but the more persistent persons insisted upon something being done. It was in vain they were told that if the foul air did not escape outside the house they might be poisoned by it inside. The only alternative was to close the ventilators complained of and erect tall shafts instead. There was a general unwillingness amongst the residents to allow ventilating shafts to be fixed against their own houses, but

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an equally general approval of their being placed against anybody else's. The difficulty was usually got over by refusing to close the surface gratings complained of, and so coercing the person who suffered most from the nuisance into consenting to the erection of a shaft somewhere upon his premises.

This course always seemed to the Author one of doubtful morality for a public body to follow. A Public Authority creates a nuisance, and refuses to abate it unless the person who suffers consents to what he believes, and what will generally be admitted, is an injury to his property. The proceeding is all the more curious as being taken by a *Sanitary* Authority.

It seemed evident that this system of erecting shafts in place of surface gratings in the road was inapplicable as a general system, because not only were they costly, having in some instances to carry the drain considerable distances from the sewer to the shaft, but they had practically all to be erected upon private property, for which the Authority was given no statutory powers.

But upon these objections came the fatal one that they failed in their purpose to put an end to the complaints. One lady against whose house a shaft had, with her consent, been erected, complained that the foul odours which had previously pervaded her drawing-room now invaded her bedroom.

The Author ascertained that the complaint was well founded. Some of the chimneys were subject to down-draughts which carried the sewer air from the ventilators into the rooms. The ventilating shaft had consequently to be removed to another spot. It has been the Author's unfortunate experience to have to remove others for similar reasons.

In recent years the adoption of tall shafts has greatly increased, and as the difficulty of obtaining consents to erect them on private property became felt, shafts were introduced, designed to stand in streets independently of support other than that secured at their bases.

To ventilate a system of sewers throughout a town by means of such shafts—which to be free from nuisance and danger, if indeed that be possible, must be carried a very considerable height above the highest windows in the neighbourhood—would indicate on the part of the engineer a state of despair of finding any other solution of the difficulty. The obstruction already caused by gas and electric lamp columns, and still worse by

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tramway trolley wire poles, feeder boxes, and numerous other things is bad enough, but the intrusion of these tall shafts constantly proclaiming the discharge of foul air—notwithstanding the mask of decoration sometimes worn by them—even though the proclamation may not always be true, is a thing which no person would desire to see.

The failure of the ventilating shafts to stop the complaints led the Author to investigate the conditions under which the surface gratings became offensive, the sewerage system of the district in question lending itself admirably for the purpose.

Sometimes a grating would be offensive one minute, and the next would not give forth a trace of smell. He rigged up a small anemometer, or rather anemoscope, constructed of cardboard, and took a large number of observations. The instrument did not *measure* the currents flowing, but merely indicated the direction and comparative velocity of flow.

It soon became apparent from the observations that the air currents in the sewers were extremely erratic. A violent current would be rushing *out* of a ventilator one minute, the next it would be perfectly still, and the next the air would be passing as rapidly in the opposite direction *into* the sewer. No variations of temperature, barometric pressure, or change of volume of sewage could account for these extraordinary evolutions, and the Author concluded that by far the most important factor in producing and determining these air movements was the wind.

There seemed no difficulty in attributing to the wind these rapid changes. The wind blowing in a certain direction over the surface of the road might (depending upon the inclination of the road) be acting exhaustively upon a ventilator, inducing a current outwards; the wind passing over the same ventilator in another direction might press inwards, and therefore reverse the direction of the current.

This change of current in a single ventilator would in all probability affect a dozen others in its neighbourhood.

In pursuing his investigations with the anemoscope one fact strongly impressed the Author. Of course, when the air was flowing inwards there was an entire absence of smell; when the air was still there was no smell; when the instrument indicated a rapid current outwards then there was inevitably accompanying it a most unpleasant odour; but the one fact which was parti-

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cularly noticed was, that if the air were moving outwards from the ventilator at a slow rate no smell was observed, diffusion with the external air apparently rendering it quite imperceptible.

It seemed possible that this circumstance might be taken advantage of to solve this very vexed question.

Not long after the Author's appointment as chief engineering assistant at Worcester, the sewer ventilation question became acute owing to the number and strength of complaints in various parts of the city.

Sewer gas destructors—with which doubtless all present are familiar—were tried. They were of course very costly, but the first consideration was the health of the citizens. The gas furnaces consumed from 8 to 10 pounds' worth of gas per annum, so that the cost capitalised amounted to something like 300*l.* for each destructor; and as the sectional area of the air passage was comparatively small, it was evident they would have to be erected at relatively short distances apart to afford a proper relief to the sewer when any rapid increase of volume occurred. The apparent object of this appliance was to set up a rapid circulation of air in the sewer towards itself, and then destroy by heat any dangerous germs and offensive particles of matter the sewer air might contain. The current of air induced, however, was found to be so feeble that when the gas was burning it failed to ensure an inward current of air at the next surface ventilator, which was situated within 70 yards of the sewer gas destructor. Possibly it had the effect of destroying any germs in the air when the gas was burning, but it was so frequently blown out by the superior draught downwards into the sewer, that the inhabitants of the neighbourhood had to consider which was the less objectionable, coal gas or sewer gas. It need scarcely be said that the number of these sewer gas destructors was not multiplied.

The most popular practice at present in vogue in seeking to prevent the foul odours, is that of endeavouring to obtain as great and as rapid a circulation of air in the sewers as possible; and endless methods of extracting the air from sewers or forcing air into them have been devised for the purpose, and an immense amount of time and labour spent in elaborate observations for ascertaining which invention most successfully accomplishes that object. This has always struck the Author as an extraordinary practice ever since he ascertained (what might natur-

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ally have been expected) that the more rapid the current issuing from the ventilator the more foul the smell. It seemed to him about as reasonable to pump the foul liquid from the sewer for the purpose of watering the streets, as to send forth at certain points into the atmosphere on which our lives and health depend, as much as possible of the foul and poisonous air of the sewers. Such a practice requires a good deal of justifying.

It will be gathered from the foregoing remarks that the Author believes that the solution of this problem lies, so far as the prevention of nuisance is concerned, in checking the rapid discharge of sewer air from the ventilators, or in other words, in transmitting as little air as possible from the sewers, consistently with affording such relief as will prevent the pressure therein rising appreciably above that of the atmosphere.

In describing the appliance by which he has endeavoured to attain this object the Author desires to state that he has no pecuniary interest in it—nothing more than a paternal affection. He did patent the arrangement some years ago, but as he was unsuccessful in persuading anybody that it was of any use, he allowed the patent to lapse. However, he is not one of those who think that a meeting of this Association is not the place to introduce methods or appliances which are subject to patent rights. If a thing is useful to Members of the Association, the fact of its being patented cannot make it less useful, and that Members should be deprived of the benefit which information about it may impart, because an individual may derive special benefit, does not seem to him either reasonable or desirable.

The object sought to be attained in the Author's invention was to prevent any appreciable rise in the air-pressure of the sewer, and yet maintain a very slow movement of the sewer air in its exit from the ventilator. To do this it was obviously necessary to distribute the outflow as evenly as possible over all the ventilators in the neighbourhood, and exclude any active interference on the part of the wind.

This was accomplished by causing the air to pass through a layer of cotton-wool. It allowed a gentle ingress and gentle egress to the air as the conditions within the sewer required. The effect of the wind was practically excluded.

This material also possessed the property of *filtering* the air in its passage through it. Hence, if any injurious micro-organisms were present in the sewer air, it is certainly reasonable to assume

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that the chance of their being transmitted into the atmosphere would be immensely diminished by the layer of cotton-wool, and rendered still less probable by the checking of the rapid air currents along the sewers, which carry away from their sides the dry particles of matter to which the micro-organisms in all probability attach themselves.

The arrangement first consisted of a diaphragm of the material, about 3 inches thick, contained in a zinc cylinder and supported by a wire netting. A number of them were placed in a length of 18-inch sewer which had been specially complained of.

In order to ascertain whether these ventilators afforded a proper relief to the sewer, during rapid increase in the volume of liquid therein, observations were taken by means of a King's gas pressure gauge, which was capable of measuring pressures down to $\frac{1}{100}$ of an inch of water.

A flushing tank containing about 1000 gallons was repeatedly discharged into the sewer, and in no instance did the gauge indicate a pressure exceeding $\frac{1}{12}$ of an inch of water, and that only momentary.

These ventilators remained in that length of sewer throughout the summer months, and so far as curing the cause of complaints was concerned, were perfectly successful. The Author was then anxious to see how they would behave in the winter, when the external temperature was much below that of the sewer. When winter came he was not much surprised to find that the discs of cotton-wool became literally sodden and useless. They either shrank so small as to allow the air to pass freely round them, or they filled up the space with a practically air-tight plug. Such a condition would often be produced in a single night if the air were cold and frosty. The problem was then reduced to finding a means whereby the wool might be kept in a dry condition. It was not difficult to protect it from rain or surface water: the difficulty lay in preventing the condensation upon it of the moisture, with which the sewer air was often saturated, and that again resolved itself into devising a means whereby the temperature of the cotton-wool could always be kept above that of the sewer air; because, it is scarcely needful to add, that condensation only takes place when the temperature of the object in contact with the moist air is lower than that of the air itself.

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This object might have been attained by placing a gas jet beneath the disc burning a small flame of about one cubic foot per hour. The cost of the gas would have amounted to about 1*l.* per annum for each ventilator. But the Author met the difficulty by designing a ventilator—which could take the place of the ordinary street surface grating—whereby the heat contained in the sewer air was made to raise the temperature of the cotton-wool above that of the air which warmed it. In the diagram, A is a cylindrical casting having ribs projecting inwards for the purpose of increasing the surface of contact for absorption of heat; the lower part of this casting rests upon the ventilating shaft which rises from the sewer. The top of the casting carries the surface grating. B is a separate casting which is kept thermally insulated from A. The lower part of this casting is also ribbed for the purpose of securing the maximum abstraction of heat; the upper part of it consists of a cylinder enclosing the layer of cotton-wool, which is supported by a grid under which is an arrangement of gills forming part of the casting. In the centre of the gills a cup is formed which if desired can be used to contain a disinfectant or germicide. The Author has never made use of it, not believing it necessary.

Upon the top of the inner cylinder rests a conical glass cover to protect the wool from water getting in from the surface.

When air passes outwards from the sewer to the external atmosphere, it takes the course indicated by the arrows. It first comes into contact with the inner casting which extends a short distance down the shaft, and when the temperature of the atmosphere is below that of the sewer air, the cold metal lowers the temperature of the latter, causing it to part with some of its moisture, which condenses upon the metal. The heat abstracted from the air is conducted upwards by the metal, raising the temperature of the cylinder surrounding the cotton-wool, and consequently by radiation from the inner surface of the cylinder, raising the temperature of the cotton-wool also, the outer surface of the cylinder being surrounded by non-conducting material.

The air, after playing round the lower part of the inner casting, passes into the annular space between it and the outer ribbed casting which is in contact with the cold earth, and at the surface of the ground with the external atmosphere; this cold metal lowers still further the temperature of the sewer air, depriving it still more of its moisture, which trickles down into

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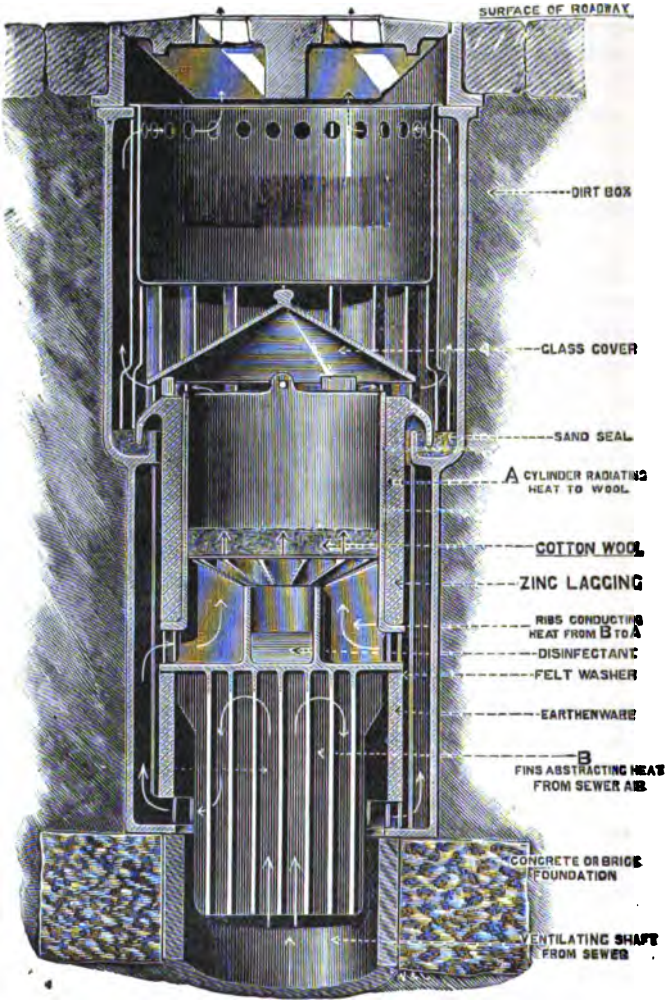
the sewer. The air now, although containing much less moisture than before, is still saturated owing to its temperature being correspondingly lowered. It then leaves the outer casting and



returns to the upper part of the inner one, passing through the openings between, and coming into contact with the gills before mentioned, whereby its temperature is somewhat raised and consequently rendered dry; it then passes through the cotton-

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wool which has been warmed by conduction and radiation above the dew-point of the sewer air passing through it, and escapes under the glass cover to the grating at the surface.

The question is sometimes asked, "How can you tell that any air at all from the sewer passes through the cotton-wool?" The question would not be put by a person who had experimented with the material in that way, but the evidence of it is afforded by the deposit of moisture which often takes place upon the under side of the glass cover, while the upper side remains perfectly dry. In the early apparatus the Author made, this cover was constructed of zinc, and the deposited moisture used to fall upon the layer of cotton-wool. He was aware that glass possesses a large capillary attraction for water: he therefore designed a cover of that material, having such an angle of slope as would cause the water to trickle down its under surface into the annular cup forming the seal. This seal has generally been made with sand, and this answers where much top-water is not allowed to rush in, but in some instances it may be necessary to deepen the annular cup and provide a water or glycerine seal.

The practice of the Author is to change the filtering material every three months. The cost, both of the material and man's time, is trifling.

The cotton-wool is seldom any the worse for being in, except from dust, spiders' webs and the like. It is sometimes damp, never wet. A slight dampness does not interfere with the transmission of air; but it would undoubtedly add to its efficiency as a filter of the organisms, the microscopic globules of water more effectively arresting and retaining any minute particles of solid matter, whether dead or living, than perfectly dry fibres. The apparatus altogether is quite successful in attaining the object desired; at the same time it may not be the best possible arrangement that can be devised, neither may cotton-wool be the best material to use, and other Members of the Association will probably improve on both; nevertheless, as it is, the Author is persuaded that it renders unnecessary the many costly and ugly devices adopted for getting rid of the nuisance and danger to health arising from the ventilation of sewers, whether they be tall shafts, water sprays, gas furnaces, chemical deodorants, air fans, or the numerous other arrangements that have been employed.

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Sir Charles Cameron, the Medical Officer of Health for Dublin, has designed a ventilator in which the principles above advocated have been applied, but in lieu of cotton-wool he employs cylinders made of a porous material, consisting of a mixture of plaster-of-Paris and clay. He has stated that they succeed in their purpose, and that the pressure of the air in the sewers never rises appreciably above that of the atmosphere. The Author has had no experience of them, and cannot therefore speak from any personal knowledge of their working.

Objections to the principle of preventing a free circulation of air within the sewers have been raised upon the ground that men have sometimes to enter the sewers for cleansing, and that therefore a certain degree of purity of the air is needful.

But special conditions should be met by special provisions. It is an easy matter to give a free circulation for a few hours to a particular length of sewer for the purpose mentioned. When boiler flues need cleaning it is first necessary to cool them, but nobody thinks *that* a reason why flues should not be used for conveying air at a temperature which a man could not live in.

It will probably be suggested, and, the Author thinks, rightly, that the principle which he has advocated takes us back to the idea which originally underlay the ventilation of sewers, viz. merely the providing of safety valves for preventing pressure upon the water traps of the connected drains, rather than the *purification*, by dilution and circulation, of the air within the sewers; a process which seems to have been suggested in the hope of being able to render the sewer air sufficiently innocuous to allow it to escape freely into the atmosphere, even in densely populated streets, without being offensive. That hope has not been realised, and the question appears to the Author to resolve itself into, whether, if the former principle can be successfully adopted, it is any longer necessary to continue what appears to be a hopeless search for a method of successfully accomplishing the latter.

To refer very briefly to the subject of the ventilation of house drains. There has been of late years a manifest disposition to mix this question with that of the ventilation of sewers, and consider them together as a single problem. The Author regards them as entirely distinct.

He would separate the house drain from the sewer in the most absolute manner practicable, and, having regard to the

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different conditions to which they are subject, would not necessarily apply the same principle of ventilation to both.

There are engineers who advocate the employment of private drains as ducts for the ventilation of the public sewers. That principle is opposed to the maxim propounded by medical officers, "make each house drain perfect, and let the public authority deal with the public sewers."

It is generally admitted that the maxim is good in theory, but it has been objected that it shifts the responsibility from the medical officer to the surveyor. Supposing that were the case. "Is the surveyor unequal to the responsibility?" Is he prepared to suggest that the medical officer is better fitted to solve the sewer ventilation problem than he? But the responsibility of the public sewers already rests upon the surveyor, and has therefore no need to be shifted upon him, and the Author is convinced he has no desire to transfer it in any respect either to the medical officer or the private individual.

A potent reason why private drains should not be used to ventilate public sewers is, that it is almost universally recognised that the most successful known method of preventing the spread of infectious diseases is by isolation.

While that doctrine is held, the necessity for the disconnection of house drains from the sewers must be admitted also. The Author can scarcely conceive a stronger case for isolation than the separation of the dwelling house from the sewerage system. Sewers are recipients of every description of filth, and the conveyors of the fæces from persons suffering from every form of disease. Hence the more the transmission of emanations therefrom into the vicinity of dwellings is rendered impossible, the safer for the occupants of those dwellings.

Whether the usual disconnecting syphon is the best method of effecting the separation is another matter. They have often been objected to on the ground that they retain foul matter which may give off offensive odours, but efficient flushing may always be counted upon to clear a properly designed and dimensioned trap of any substance that ought to be allowed to find its way into drains.

With regard to the method of ventilating private drains, the Author agrees with the general provisions of the model bye-laws, with perhaps the sole exception that he would reverse the relative positions of the opening near the surface of the ground and the

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tall shaft, in order that the current of air should follow the flow of water, which it will invariably do if the latter is running rapidly, whatever relative levels the surface opening and tall shaft may occupy. By the arrangement laid down in the model bye-laws the flow of the liquid opposes the current of air; by the alternative arrangement suggested it assists it. The Author, however, would prefer to dispense with the surface opening entirely on the private drain, and construct tall shafts for both inlet and outlet. The difference in the conditions obtaining in an ordinary house drain, from those of the sewers is, that in the former the discharge is limited to a single house, is spasmodic, usually rapid, occurs only at intervals more or less long, and the matter flowing along it is fresh and undecomposed. In a sewer not one of these conditions can be counted upon: on the contrary, more generally every one is reversed.

In the case of a large establishment such as an asylum or hospital, the main drain becomes practically a sewer, and should be treated as such, both as regards disconnection of house drains and ventilation, and also flushing.

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THE VENTILATION OF SEWERS AND DRAINS.

By R. READ, Assoc. M. Inst. C.E., City Surveyor, Gloucester.

This subject has been a fruitful source of controversy for the last twenty-five years, but it has rarely been discussed under more favourable conditions than the present. Usually the papers on this subject are crowded in amongst a number of others, or they are discussed by people who have no real knowledge of it; but here we have a gathering of gentlemen, each one of whom has a system of actual live sewers, in daily operation, under his charge; and it is only those who have studied the working of a system of sewers for at least twelve months, so as to observe them under all conditions of weather, and season, who are capable of forming a correct judgment on the matter. And even to such a gathering the Author would appeal—as a counsel for the defence would appeal to the jury—to dismiss all prejudice and preconceived assumptions from their minds in regard to the subject in order to deal with it upon its actual merits.

Let us consider then what is the action of a system of sewers and drains, and why it is necessary to ventilate them.

A system of sewers consists of a number of branches, converging into main trunk sewers, which again converge into an outfall sewer, about nine-tenths of the whole would probably be pipe sewers, ranging from 9 inches to 18 inches diameter, and the remainiug one-tenth would probably be brick sewers. The upper ends or branches will probably have the steepest gradients, the main trunk sewers somewhat flatter, and the outfall sewer the flattest gradient of all. House drains and street gullies will be connected at every few yards along the whole of their length; so that a system of sewers is a system of perforated pipes having varying gradients, converging to a common outfall. The discharges from the house drains are intermittent, but as their aggregate length is about five times that of the sewers their

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numbers enable them to create a continuous current through the sewers, except possibly at the extreme upper ends of the branch sewers, for a distance of from 50 to 100 yards from the summit, where the drains may not be sufficiently numerous to produce a continuous current in that length of the sewers. If a system of sewers is to be self-cleansing it must be so proportioned and graded that the flow of sewage has a minimum velocity of three feet per second, or about two miles per hour, which is sufficient to discharge the sewage at the outfall from the majority of towns in two or three hours. If in some cases the gradients are not sufficient to give that minimum velocity, special methods of flushing must be resorted to, in dry weather, to keep the sewers free from deposit. If deposit occurs in a sewer it arises from one of the following causes:—

1. Flat gradients.

2. Insufficient flushing either at the w.c.'s or in the sewers themselves, the w.c.'s being the proper initial point of flushing, as from this point it traverses both drains and sewers.

3. Inefficient, or neglected, street gullies and manhole buckets; and

4. What sometimes happens in a new district, insufficient live drain connections, that is to say, the sewer will be laid in the street of sufficient size for future requirements, but there may be only half a dozen houses built and occupied for several years; the result is that, however well the sewer is graded or constructed, the sewage from this small number of houses is lost in it, the water running away, and leaving the solids stranded behind it, to be shifted on a further stage by the next discharge from the house drains.

If a deposit occurs in any sewer from bad design or bad construction, this can only be remedied by reconstruction on better lines and levels, but ventilation has often been blamed for calling attention to this requirement.

All the causes of deposit mentioned above are more or less preventable, and if there is no deposit in a well designed and constructed sewer, why is ventilation necessary?

The dry weather flow of sewage through a system of sewers gradually increases and decreases in quantity; that is to say, from a minimum at about 3 a.m. it gradually increases to a maximum about 3 p.m., remains near the maximum until about 7 p.m. when it will begin to decrease until it reaches the

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minimum again at 3 a.m. This, of course, means that a large amount of air must be displaced from the sewer, while the sewage is increasing in volume, and a corresponding amount of air taken into the sewer as the sewage decreases. The air which is displaced by the sewage must go somewhere, either up the house drains or through any manholes or ventilators which may have been provided.

Complaints of nuisance from sewers are generally confined to the six months of the year between the end of March and the end of September, and more especially occur after a few days, or a week's dry weather, then the ventilation is generally blamed by the public as the cause of the trouble. Ventilation is necessary to provide for the escape of the air displaced by the rising sewage, or the air would be under compression, and would force any traps which might be inserted for keeping it in the sewers, and the longer the time required to sufficiently compress the air to force the traps the worse would be the final result.

The methods of ventilation now in use may be classified as follows:—

1. Openings in the manhole and lamphole covers, at the street surface, at various intervals ranging from 40 yards upwards, but usually about 60 to 100 yards apart, the openings varying from 36 square inches per manhole upwards.

2. Vertical shafts attached to buildings, trees, telegraph poles, or self-supporting, 4 inches, 6 inches, and 9 inches diameter.

3. Various combinations of surface gratings and ventilating shafts, generally in wrong proportions and positions, owing to legal difficulties.

4. Connections to factory chimneys.

5. Various patent systems of induced current ventilation by means of gas jets, water jets, or compressed air.

6. Systems of deodorising the gases given off at the manholes by the introduction of chemicals.

The first system discharges sewer air or gas immediately under the noses of the people, and is uncertain in its action.

The second is an improvement on the first inasmuch as it discharges the sewer air at a point varying from 20 to 60 feet above the street level, where it is not so noticeable, and has

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the advantage of being exposed to any wind which may be blowing.

The third system, a combination of surface grids and vertical shafts, has seldom had a thorough trial in the proper proportions, and arrangement, which are necessary to harmonise with the action of the sewers and thus convert it from a haphazard into a scientific and reliable system.

The remaining systems are altogether too costly for general application, although they are occasionally useful for isolated cases of offensive manholes, to avoid the expense of a reconstruction of sewers.

Let us now consider what happens to the sewer air, in a well constructed system of sewers and drains, with the sewage flowing at the minimum rate of 3 feet per second.

In the summer-time the temperature of the flowing sewage would range between 50° and 52° F., and the sewer air over the flowing sewage would range between 52° and 55° F. in twenty-four hours, while the outer air at the ground level during the same period may range from 50° F. up to 75° F. or 80° F.; and speaking generally, during the summer months the sewage and sewer air are at a lower temperature than the outer air, while during the winter months the reverse will probably be the case; but although this is true as a general rule, there are times during possibly each twenty-four hours, in which the relative temperatures overlap each other. This is especially the case at sunset in the summer-time when the radiation from the surface of the earth reduces the temperature of the air in contact with it at the ground level to the same or a lower temperature than that of the sewer air. The result is that in cases where the sewer is ventilated only by gratings at the street surface, an escape of sewer gas occurs, generally just about dusk in the evening. But after a few days of dry weather the outer air has a low percentage of humidity, and the longer the drought continues the greater is the capacity of the outer air for absorbing moisture. The result is that any wet surface, such as the surface of the flowing sewage, and which is generally the only wet surface available, gives off watery vapour freely. This watery vapour is charged with organic matter from the sewage, and having about half the density of dry air, at the same temperature, it naturally rises from the manholes into the open air and thus causes a nuisance. This continues with increasing

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offensiveness as long as the dry weather lasts, and usually the break up of the dry weather is preceded by a fall of the barometric pressure, which again releases a further quantity of watery vapour, charged with organic matter from the sewage, and the nuisance is at its maximum, because the sewage is in its most concentrated form, the sewer air is at its maximum quantity, and the outer air at its greatest capacity for absorbing moisture. It is this watery vapour under these conditions, that the ventilation has to deal with, and which cannot be dealt with by any other means, although flushing may be a temporary remedy; but even if the borough surveyor doubles his daily consumption of water for this purpose, it would be a mere flea-bite compared to a good shower of rain. The municipal sewer-flushing can only touch the sewers, and has no effect on the house drains, which can only be flushed from the w.c.'s, the sink, and the bath wastes.

If the sewers discharge the sewage to the outfall at the minimum rate of 3 feet per second, it should arrive there long before it has time to set up putrefaction; therefore the watery vapour rising from the sewage should not be putrid; but it generally is so, for three reasons, viz.:—

1. The alternate wetting and drying of the sides of the sewer, owing to the rise and fall of the sewage.

2. The discharges from the house drains are more or less decomposed, owing to the interposition of the intercepting trap which acts as a cess-pool; and

3. For want of proper ventilation.

In the absence of any deflecting influence, vapour rising from any wet surface rises perfectly vertical, but being of so light a character, it is easily deflected in any direction, and watery vapour rising from the surface of sewage in a sewer would naturally rise vertically against the crown of the sewer, and would roll slowly along the top of the sewer in an upward direction; but the motion is exceedingly feeble, and therefore the motion of the sewage flowing at the rate of 3 feet per second, is a comparatively powerful force, which easily carries the watery vapour with it down the sewer, by friction of the two surfaces of water and air in contact; and the friction of the air and vapour against the crown of the sewer acts as a brake, retarding, but not preventing, the flow of air and vapour in the same direction as the sewage. The vapour following the flow

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of the sewage naturally eddies up each drain opening which it comes to, and also expands into the manhole chambers, so that the velocity never increases to the same rate as that of the sewage; but at the upper ends of the branch sewers, where the flow in the sewer for the first 50 or 100 yards is as intermittent as that of the house drains, the sewage has not the same power over the vapour, and its natural tendency to rise vertically may be sufficiently strong to carry it out at the top manhole grating, from that short length only, and thus gives rise to the popular error, that the sewer air from the whole system of sewers, rises towards the upper manholes of the system. This action can easily be proved by forcing smoke from an Eclipse machine into a manhole, say in the middle or at two-thirds from the lower end of a street sewer, with the smoke nozzle in the sewer, pointing up the gradient, and it will be found that the smoke will appear in succession at all the manholes below this until the sewer is full of smoke, when it will also come out of the manholes above the point of entrance.

Any system of ventilation, to be efficient, must coincide with these actions of the sewage and sewer air; each length of sewer between a pair of manholes must have its own system of ventilation, the inlet being at the upper end of the length, at the street level, and be kept as small as practicable, and the outlets distributed at even distances over the length below to the next manhole, and be as numerous as possible. This can only be done by abolishing the interceptor, and making the ventilating shafts on every house drain assist in ventilating its own length of sewer, between the nearest manhole on either side of it. In this way, a large number of ventilating shafts above the houses are brought to bear upon the one inlet at the upper end of the, say, 100 yards length of sewer, and therefore, the air enters at this inlet with a velocity greater in proportion to the difference between the area of its opening and the aggregate of the number of shafts between it and the next manhole below, and the greater the excess of the shaft outlets over the manhole inlets, the stronger will be the velocity at the inlet and the less liable will it be to be reversed.

If there is any wind, however slight, or from whatever direction it is blowing over the tops of the outlet shafts, provided that it is not artificially deflected, this will only increase the velocity at the inlet. This proposal has always been met

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by the statement that you are passing the sewer gas through the house drains, and thus endangering the health of the inhabitants of the houses; and it was to try and prevent this that the intercepting trap was adopted, without investigation of any kind, into the Model Bye-Laws in 1877, because the doctors said that "sewer gas must be cut off from the houses." As an abstract proposition this requirement is perfectly correct, but the method of carrying it out by means of the intercepting traps is both absurd and dangerous. The trap is no protection to the house whatever, the real safeguard being the soundness of the drains. If the drain is sound the trap is absolutely useless, and a dangerous obstruction; and if the drain is not sound, the trap is also useless, because the emanations from the drain itself, and from the stagnant sewage in the trap, are quite sufficient to poison the whole household without any aid from the sewer. Intercepting traps, in their most approved form, hold about two gallons of stagnant sewage; they cause a retention of from 25 per cent. to 30 per cent. of the solid matter in the trap; they paralyse the flow through the whole length of the house drain, and cause it to become coated with putrid sewage throughout; and they absolutely prevent proper ventilation of the sewers. They are liable to be forced from the sewer side by the compression of the sewer air against them by the rising sewage; they necessitate a brick chamber and a so-called fresh air inlet, which has by force of circumstances to be placed within a very few feet of the front door, or front window, of the house, and every time the drain is used, the mica flap-valve in connection with this fresh air inlet is violently closed, and if the valve is not very soon broken by this violent flapping action the compression of the air in front of each discharge from the w.c. against the sewage in the intercepting trap partially untraps it. The drain air then passes on into the sewer, and the sewage dribbles slowly into the inlet side of the trap, and slowly out of the outlet side, in the feeblest possible manner, into the sewer charged with putrefied organic matter, which the sewer ventilation, in whatever form it may exist, has to deal with, and gets the blame for. Equilibrium is restored by the sewage filling up the trap, and the process is repeated by the next user of the drain; but in the majority of cases the flap-valve at the fresh air inlet is either not air-tight, or is broken, and if the intercepting trap escapes being forced, owing to this defect in the

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fresh air valve, a strong puff of drain air is discharged under the windows or by the front door of the house during every use of the drain. The usual result of this is that the householder promptly stops up the fresh air inlet altogether, and then the last state of the intercepting trap and drain is worse than the first. And besides all this, the intercepting trap is liable to partial stoppages by an excess of paper, or a dish cloth, or any solid matter being put down the drain, then the sewage rises in the intercepting chamber and drain, until it has obtained sufficient head to force the obstruction, and some 30 square feet of brick surface is fouled with sewage. But occasionally the head in the chamber is not sufficient to force the obstruction, and then the builder, or the inspector of nuisances, or both, have to be called in, the obstruction is pushed down to the bend in the sewer junction, and a message sent to the surveyor, that the sewer is blocked, although the neighbouring drains are still running.

In the majority of towns now, all drain joints are made in cement, and the drains thoroughly tested before being allowed to be covered up, or used, and strict regulations are made as to the fall, usually not less than 1 in 48 or ½ inch to a pipe being specified, and any inspector on testing the pipes, and finding one with a back fall, or merely level without any fall at all, would immediately condemn the drain and have it pulled out and relaid. But the same inspector, under the Model Bye-laws, is compelled to introduce into the lower end of the flattest part of the drain, an intercepting trap, which causes an obstruction from 6 inches to 8 inches deep, full of stagnant sewage; and the believers in this trap assert that they are thereby saving the lives of the inhabitants of the house, by cutting off the sewer gas, a statement which is altogether erroneous, as the trap is simply a manufactory of sewer gas on every house drain, pouring sewer gas into the sewer, which any system of ventilation of the sewers is blamed for, and is powerless to deal with, or prevent.

The patentees of a certain chemical process contend that owing to the temperature of the sewer air being generally cooler during the summer than the outer air, it is impossible for it to rise out of the sewer during the summer months, especially if charged with the heavier gases of decomposition, and that it accumulates during these months, to be discharged during the autumn or winter, when the sewer air is generally warmer than

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the outer air; and in this way they account for epidemics such as typhoid and diphtheria occurring in the autumn. But this statement about the differences of temperature during the summer and winter months is only partially correct, as has been shown in an earlier part of this paper. There are times during the twenty-four hours, more especially about sunset, when the temperatures overlap each other, and thus bring the sewer air out into the outer air; and there is also the difference in density of the watery vapour, as compared with the outer air, constantly acting in dry weather, as well as the fall of the barometric pressure, causing discharges of sewer air into the outer air, quite independently of the relative temperatures.

In conclusion, the Author would like to try an experiment, by omitting the interceptor trap on all drains which are outside the houses; the drain will thus get a better gradient throughout, and no possible harm can be done to the householders, while great benefit would accrue to the sewer, which would be properly ventilated and be kept much cleaner.

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VENTILATION OF SEWERS.

By W. J. STEELE, Assoc. M. Inst. C.E., Deputy City Engineer of Bristol.

When this subject has been discussed at the Meetings of the Association, Bristol has frequently been mentioned as a city where the sewers are not ventilated; it may, therefore, be interesting to consider the general conditions of its sewerage system.

All the manholes and lampholes on the sewers in the city are surmounted by closed covers, and no means are intentionally made to provide a communication between the sewers and the atmosphere.

There are eight outfalls into the river Avon, fitted with tidal flaps, the head against the bottom of which, at high water of ordinary spring tides, varies from 7 to 20 feet. Six small storm overflows from one intercepting sewer discharge into the river Frome, four being fitted with flaps.

The city forms a basin, the general level of whose perimeter is about 240 feet above the Ordnance Datum, and whose centre is about 27 feet above such datum, consequently the fall on the sewers is considerable.

In the central and ancient portion of the city, which is nearly all below the 50 feet contour, there still remain several branch masonry sewers of a more or less air-tight description; in passing it should be said that these are gradually being superseded by others of a modern character.

All street gullies are trapped.

Since 1882, drains connected to the sewers have been provided with an intercepting trap. On the building side of this trap, a communication is made with the atmosphere, and another near the highest point of the drain. Every building used for human habitation is provided with at least one water-closet, usually of the pedestal form, and all roof water, bath and sink waste pipes, discharge over trapped gullies.

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Prior to 1882, intercepting traps were not compulsorily fixed in the drains, although some were voluntarily, but before this date, the sink-stones, water-closets, baths and similar fittings were provided with some form of trap. Possibly there are several instances where a roof water-pipe forms a means of communication between the sewer and atmosphere, owing to there being no water-seal between such pipe and the sewer; unfortunately, however, the number cannot be stated with any degree of accuracy. If any notification of bad smells in or about buildings is received, the sanitary inspectors of the health department immediately make an investigation, and, if necessary, cause the drainage system to be modified on the lines indicated above; during the year ended December 31, 1901, over 4800 systems were amended.

During the year ended December 31, 1902, only ninety-one complaints were received of bad smells in the streets, and these were in every case found to be from gullies, which from defective traps, had the water-seal broken.

From what has been stated above, is it possible to say that the practice as applied to Bristol, of not intentionally providing any means of communication between the sewers and atmosphere, is wrong in principle? In the light of what is known about this subject at present, the Author ventures to think that a correct answer cannot be given; but he would ask, What are the functions of a sewerage system? In his opinion, they are the means of removing the liquid refuse of a community with as little danger to the public health as is possible; even on economic grounds, the health of the inhabitants of a town is of importance, as lowered vitality means loss of earning power.

It may be stated with truth, that the death rates are as reliable a test of the health of a community as is at present known, because if the vitality of a person is lowered—and it is admitted that foul air will cause this—such person's capacity for fighting a disease is reduced, and the death rates are accordingly affected.

A table is given showing the death rates per 1000 living during the ten years 1891 to 1900 inclusive, of the average of the thirty-three great towns and those which may reasonably be said to be of a similar character to Bristol. Brighton and Croydon are inserted, although they do not quite resemble Bristol, inasmuch as they are of a residential character, whereas Bristol

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is principally a manufacturing locality; but as they are celebrated for low mortality rates, it has been thought advisable to include them. The income of the average individual is likely to be higher in a residential locality than in one of manufacture—an important factor in considering the health of a community; moreover the risk of death in the former, owing to the nature of occupation of the inhabitants, is less.

The epidemic diseases, diphtheria, fever and diarrhœa, are given as they are said to be the only diseases in which sewer air plays any part, directly or indirectly. The infantile mortality is given as showing the chances of life of infants under one year.

Name of Town.	Population.	Death Rate per 1000 Living, for Ten Years, 1891–1900.				Deaths under One Year to 1000 Births.
		All Causes.	Diphtheria.	Fever.	Diarrhœa.	
33 Great Towns	11,464,957	20·2	·34	·20	1·00	172
London	4,544,983	19·6	·50	·15	·78	160
Birmingham ..	523,391	20·8	·24	·20	1·27	187
Bradford ..	280,163	18·9	·09	·17	·90	171
Brighton ..	123,688	17·7	·25	·13	·81	156
Bristol	329,990	18·3	·17	·11	·66	147
Cardiff	165,245	18·7	·47	·14	·91	161
Croydon	134,697	14·5	·26	·09	·61	136
Leeds	430,575	20·2	·29	·20	1·13	179
Leicester ..	212,537	18·3	·43	18	1·54	195
Liverpool ..	686,454	24·5	·20	·33	1·36	191
Manchester ..	544,923	23·9	·19	·22	1·37	190
Newcastle ..	215,972	21·3	·18	·16	·77	174
Nottingham ..	240,431	18·8	·09	·29	1·17	183
Portsmouth ..	189,112	17·9	·26	·27	1·04	160
Sheffield	382,269	20·8	·39	·29	1·40	185

From all causes, the Bristol rate is higher to a degree in the order named, than that of Croydon, Brighton and Portsmouth, equal to that of Leicester and lower than all others.

From diphtheria, the Bristol rate is higher than that of Bradford and Nottingham. but lower than all others.

From fever, the Bristol rate is higher than that of Croydon, but lower than all others.

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From diarrhœa, the Bristol rate is higher than that of Croydon, but lower than all others.

The infantile mortality in Bristol is higher than that of Croydon, but lower than all others.

It is reasonable to ask, if the death rates of Bristol, although comparing favourably with those of other towns of a similar character, could be reduced if special means were taken to ventilate the sewers; but so far as the Author knows, no system has yet been found which could be tried in any district of the city without detriment to the others. Ventilation by means of open manhole covers is generally admitted to be unsuccessful; the Author thinks it worse in principle than open sewers, because the emission of the sewer air would be concentrated at fixed points, and when the atmosphere is practically quiescent the vicinity of some manholes would become unpleasant.

A reference to the contour diagram will show that if shafts were erected so as to have direct communication with the sewers, the atmosphere of the higher sections of the city would conceivably be charged with the sewer air from the lower sections during very light breezes, as it will be noticed that in some districts there is a difference in level of 150 feet in a horizontal distance of only 1200 feet. If shafts were erected in the higher sections of the city only, it is doubtful if a sufficient number could be fixed to influence the air in the lower sections, as it is well known that sewer air does not always travel up a sewer.

None of the numerous methods of incinerating, washing or filtering the sewer air before it emerges into the atmosphere, have yet been proved, so far as the Author knows, to be practicable if applied to the whole sewerage system of a large town.

A table is given showing the districts into which the city is divided for health control, the lines of the main outfall sewers, and the area where the sewers are tide-locked at high water of ordinary spring tides, with a view of ascertaining if the health of any particular district is affected where the main sewers are situated, or by the air in the lower levels of the sewers being forced into the higher. The average death rate given is for a period of three years, as the districts were rearranged in 1898.

An examination of this table and diagram in conjunction with other conditions affecting the various districts, does not show to the Author that the death rate is influenced by provision

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not being intentionally made for the sewers to have a communication with the atmosphere.

Name of District.	Density of Population per Acre.	Average Death Rate for Three Years ending 1901.	Relation of District to Tide-locked Area.	General Level of District.
Ashley	42·70	12·18	Above	Small portion below 100 feet contour, remainder above.
Bedminster ..	18·40	17·14	About one-fourth in tide-locked area.	About one-half below 50 feet contour, remainder above.
Knowle		17·88	Above	About one-half below 100 feet contour, remainder above, of which about one-half is above 200 feet contour.
Clifton	27·20	12·67	Above	Small portion below 50 feet contour, about one-third below 200 feet contour, remainder above.
Redcliff	47·20	18·85	Wholly in tide-locked area.	Practically wholly below 50 feet contour.
St. Augustine	61·20	15·09	About one-fourth in tide-locked area.	About one-third below 50 feet contour, one-half below 100 feet contour, remainder above.
St. George ..	27·30	15·60	Above	About one-fourth below 100 feet contour, one-half below 200 feet contour, and remainder above.
St. Paul ..	136·10	15·09	About one-seventh in tide-locked area.	About one-half below 50 feet contour, and one-half below 100 feet contour.
St. Philip ..	71·00	16·06	About one-third in tide-locked area.	Wholly below 50 feet contour.
Stapleton ..	7·50	12·88	Above	Practically wholly above 100 feet contour, about one-third being above 200 feet.

The manufacturing area of the city is principally confined to St. Philip, Redcliff, Bedminster, St. George and St. Paul.

The Ashley, Clifton and Stapleton districts, which have the lowest rates, are at a high altitude, outside the tide-locked area, and the strata at a small depth below the surface is rock.

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The Redcliff district, which has the highest rate, is in the manufacturing area, on a low level and intersected by the river Frome and Floating Harbour, which may conduce to a damp subsoil.

Without closer study, it is difficult to account for the comparatively high rate of the Knowle district which is at a high altitude and outside the manufacturing area, except that until about four years ago it was principally drained into cesspools.

A large portion of the Bedminster district is in the manufacturing area, on a low level and adjoining the southern side of the river Avon which intersects it; the subsoil is a soft description of clay.

St. Philip is largely a manufacturing district, on a low level, and the subsoil of a considerable area is soft clay and peat.

When the sewers become tide-locked or are charged by heavy rainfalls, it may be asked, what becomes of the sewer air? A portion may enter the ground surrounding the sewers where they are not air-tight, a portion may escape into the atmosphere by means of directly connected roof-water pipes or defectively trapped gullies and other drain fittings. These possible outlets may not be sufficient for the escape of all the displaced air, and an additional assumption is advanced that the water-seal of the intercepting traps on the drains is put under pressure, and should any air be forced through the seal it escapes up the vent pipes on the drains. Experiments are now being conducted to ascertain if this does happen.

An intercepting trap fixed in a drain is said to be objectionable, inasmuch as it retards the flow of sewage and thereby affects the vital principle of a drain being self-cleansing, and with this the Author is agreed; but it is a necessary evil as applied to the drains in Bristol, because without it, every vent pipe at the head of the drains in the lower districts of the city would become a vent to the sewers of such districts to the detriment of the districts on a higher level.

The responsible authorities in Bristol have quite an open mind on the question of sewer ventilation in general, but they hold the view that it has never been demonstrated that the practice at present applied in Bristol is prejudicial to the health of its inhabitants.

In considering the subject as a whole, the Author ventures to submit that the numerous experiments made in various towns

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have been somewhat incomplete, and thinks, if any general principle can be laid down, it should be done by a commission representative of Preventive Medicine and Engineering, which might experiment throughout the United Kingdom.

The following points occur to the Author as requiring solution based upon full experimental data, viz. :—

Is it necessary to continuously admit atmospheric air to a properly constructed sewerage system, and if so, how ?

Is it necessary to continuously provide a vent for the air displaced from a properly constructed sewerage system by various causes, and if so, how ?

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THE VENTILATION OF SEWERS AND DRAINS, WITH SPECIAL REFERENCE TO THE UTILISATION IN CONNECTION THEREWITH OF FLUSHING-WATER.

By AMBROSE W. CROSS, Assoc. M. Inst. C.E.,
Surveyor to the Urban District Council, King's Norton.

It is not intended in this paper to touch, except very briefly, on the general aspect of the question of sewer and drain ventilation, the primary object being to bring under notice and invite discussion on a system of sewer ventilation having features of novelty, which system, after somewhat prolonged experiment, has recently been adopted in the Urban district of King's Norton and Northfield, of which the Author is Engineer and Surveyor; and further, to suggest a method by which the latent power stored in the water which in many towns is passed from a water main under pressure into a flushing-tank, may be utilised to materially assist in the ventilation of the sewers and drains.

Speaking generally, it has for many years been contended that, given properly designed and constructed sewers with good self-cleansing gradients, the decomposition of the sewage which gives rise to the generation of noxious sewer gas should not take place, thus removing one of the principal causes of offensive emanations from sewer ventilators.

Assuming that to be so, it was further contended that open gratings at road level ought to be sufficient to harmlessly pass off into the atmosphere any outflow of sewer air, and also to admit fresh air into the sewers.

Such contentions seem fairly correct in theory, but experience has shown that even in towns where the whole system of sewers may have been brought up to date, and may, as regards gradient and construction, be beyond reproach, there are influences at work which bring open sewer gratings (if they have been adopted)

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into bad odour, and sooner or later cause complaints in one locality or another, and eventually lead to the substitution of one or other of the more or less improved systems of sewer ventilation.

The numerous systems or methods which the Author has during his twenty-five years' connection with municipal engineering seen brought forward as improvements on the open grid system, may be said to divide themselves into three distinct categories, viz.:—

1. *Systems of unaided natural ventilation which aim at rendering the issuing sewer air innocuous, so as to permit of its being delivered through open grids at the level of the street.* These include, *inter alia*, the following contrivances, which are generally placed in the manholes or lampholes: (*a*) filters of cotton-wool, charcoal trays, etc.; (*b*) asbestos gratings soaked with disinfectants; (*c*) an apparatus for generating by a combination of chemicals, antiseptic fumes which according to the direction of the air-current, either mix with the issuing sewer air or with the fresh air entering the sewer.

2. *Systems of assisted natural ventilation which aim at controlling the direction of the air-currents in sewers and drains, and delivering the sewer air at such a height above ground as to make attempts at purification unnecessary.* Amongst these may be mentioned: (*a*) tall vent-shafts (30 to 40 feet high), or factory chimneys, as outlets, with open grids at road level as inlets; (*b*) tall vent-shafts (at much shorter distances apart than in the last mentioned system) to act either as inlets or outlets according to the direction of the wind or other controlling influences, and having no open grids at road level; (*c*) tall vent-shafts as outlets, with inlets controlled by non-return mica-flap valves, usually placed either in manholes or lampholes below ground, to prevent them acting as outlets.

3. *Systems of mechanical or assisted natural ventilation which also aim at rendering the issuing sewer air innocuous, thus enabling either open grids at street level or short outlet shafts to be used.* Amongst which may be mentioned: (*a*) outlet shafts with gas fires in the base; (*b*) gas lamps with air-tight lanterns compelling the burners to draw their air supply from the sewer to which they are connected; (*c*) an apparatus placed in a manhole or in any other suitable position which aims at utilising the power of a water-jet from a pressure supply to extract air from the

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sewers, and force it through a body of water with the object of freeing it from its impurities by washing.

The Author's experience leads him to the following general conclusions on the various systems referred to above :—

That as regards the systems in the first category, open gratings at street level are equally unsatisfactory whether they be numerous or few, whether they be open and unobstructed, or have filters of any kind to offer resistance to the free circulation of air through the sewers.

That any system in category (2) which relies on the extracting power of tall shafts for compelling the open grids at ground level to act as air inlets only, are unreliable, and that the Borough Engineer of West Ham was not far wrong when reporting to his Committee in September 1899 as follows :—

"The theory that the air will enter the surface grid and pass up the ventilating shaft is not found to hold good in practice, and it has been found necessary to close the grid where a shaft has been erected. Even with tall shafts, the currents will frequently act in the reverse way. The Local Government bye-laws are based on the above theory, but many of the complaints received are found to be due to the so-called "fresh-air" inlet. The Borough Engineer is of opinion that, although the theory of the flow of air has been disproved, the erection of a shaft, and the closing of any surface grid found to be a cause of nuisance, is the best method known at the present time for removing the cause of complaint; as even if the shaft does not permit the free inlet and outlet of air provided by the surface grid, it equalises the pressure caused by unequal flow, storm-water, etc., and allows the foul air to escape above the house tops. What apparently is required to make this system efficient is some inexpensive practical means of mechanical ventilation whereby the current of air will be kept flowing in the same direction, and so ensure the air entering at the surface grating and passing out at the ventilating pipe."

That the other systems in category (2), which consist of tall shafts only, to act either as inlets or outlets, or which combine tall shafts with controlled (valve) inlets at a lower level, can be made to give satisfactory results, and are neither very costly to instal nor very expensive to keep up.

That of the systems mentioned in category (3)—all of which, the Author believes, are proprietary—the wonderful powers

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claimed for them by their respective proprietors are probably much exaggerated and the cost of upkeep understated.

It unfortunately appears to be considered allowable for patentees and manufacturers to freely embellish their price lists or pamphlets with statements and exaggerations calculated to mislead confiding readers. Take for example the statement of a certain firm who say in one part of their pamphlet that their apparatus, which one is led to believe consumes not more than 14 cubic feet of coal gas per hour, will extract and destroy over 11,000 feet of sewer air per hour. Assuming cubic feet to be here meant, as is the case in an earlier reference in the same pamphlet to sewer air extraction, this would be equivalent to a velocity of the air entering the apparatus through a 6-inch tube, of over ten miles an hour, which one would expect to play havoc with the mantles of the incandescent burners used in the apparatus.

Again, in another part of the pamphlet, one is led to believe that the temperature of the sewer air is raised by the apparatus to about 600° F. That being so, the work done in foot-pounds is equal to 4·35 horse-power theoretical, and the cost for gas works out at about 0·09*d.* per horse-power per hour.

If the above figures and calculations be correct, the proprietors might find it worth while turning their attention to using the apparatus as a hot-air engine, if at any time it should be supplanted on the ventilation market by some newer system, which, by reason of its intrinsic merits, or by the way it is advertised, or for other reasons, relegates the older one into the cold shades of neglect.

In the belief that ventilation on the lines of system (*c*) in category (2) in combination with some method of mechanically induced air currents, offered reasonable prospects of a solution of the difficulties met with in the King's Norton District, the Author continued some experiments with water-sprays as extractors fixed at the bases of tall shafts, commenced by him when Borough Engineer and Surveyor of Loughborough.

Knowing from practical experience of factory chimneys as sewer-gas extractors, that any system relying on suction alone for inducing fresh air to enter the sewers through street grids, would fail to be sufficiently far-reaching in its effects to be worth considering, the Author at first contemplated the adoption, in connection with the water-spray extractors, of fresh-air inlets,

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consisting of revolving lobster-back cowls, or some other form of downcast ventilator head, fixed on short shafts 10 or 12 feet high, the idea being that these cowls, by always presenting an open mouth to the breeze, would utilise to the utmost the power of the wind to sweep clear of foul air the length of sewer which intervened between the inlet and outlet shafts.

On reflection, however, and as the result of experiments, it appeared probable that any form of open-mouthed downcast ventilator, would not under all conditions be proof against reverse currents of sewer air, and, therefore, the short inlet shafts might, especially when there was a stagnant atmosphere, become outlets almost as objectionable as the open gratings at road level.

To obviate this objection, the Author's next idea was to fill in the opening or mouth of the revolving cowl with non-return mica-flap inlet valves; but before proceeding to experiment on a practical scale, it occurred to him to make some experiments with a revolving Archimedean extractor-ventilator, which led him to two useful conclusions, viz. (i) that the value of an Archimedean ventilator as an extractor of sewer air was practically *nil*; and (ii) that a revolving head, whether for an inlet or outlet ventilator, would be troublesome and unsatisfactory.

The idea of a revolving head was consequently abandoned, and the catalogues of various firms of ventilating engineers were then searched in order to ascertain whether there was on the market any form of fixed ventilator head, fitted with mica-flap valves to prevent reverse currents, and which would, at the same time, catch and utilise every wind that blows, whatever its direction might be; but nothing answering the requirements was found.

A special design was therefore prepared, showing a square head having an opening in each of its four sides, filled in with mica-flaps: a sketch of the head was sent to and prices were invited from several firms, and two experimental inlet heads were ordered.

On being put to practical work on the top of short shafts these heads gave fair promise of success, but were not quite satisfactory, either as regards the fit of the mica-flaps or the method of suspending them, having regard to the question of renewal in case of wear or breakage.

At this juncture a more suitable form of ventilator head,

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hexagonal in shape and having aluminium instead of mica flaps, came under the Author's notice, whereupon extended experiments were undertaken with it, with the result that, after slight improvements in details had been effected, it proved in every way satisfactory.

On inspection of this hexagonal inlet ventilator head it will be seen that the novel method of suspending the aluminium flaps enables a damaged or worn one to be taken out and a new one substituted in about twenty seconds at a cost of a few pence.

Since the fixing of these inlets in lieu of the open street gratings was commenced in the Author's district, a month or two ago, tests with the anemometer have been made in order to ascertain to what extent they deflected the wind currents into the sewers, and the maximum rate recorded was 2098 lineal feet of air through a six-inch shaft in five minutes: as may be imagined, this occurred during a high wind. Another extending over twenty-four hours in breezy weather showed that 21,000 cubic feet of fresh air was passed into the sewers through one of these inlets fixed on a short shaft 11 feet high. This shaft was in a position where, owing to the direction of the wind and to the fact that all the street gratings in the immediate locality were left open, *there was, on removing the inlet head, a strong current outwards.*

It was originally intended that these inlet ventilators should be used in combination with water-spray extractor outlet-shafts fixed at the summits of the sewers or in other positions where flushing of the sewers was customary or desirable. Experiments by the Author at Loughborough and elsewhere had proved to him beyond a doubt, that every gallon of water passed from a water-main into a flushing tank was—assuming a pressure of 40 or 50 lb. per square inch—capable of inducing a movement of air in any desired direction equal at least to a minimum of 100 cubic feet for every gallon of water used.

Seeing that the cost of installing the water-spray apparatus would not be more than 3*l.* to 4*l.*, whilst the cost of the water, which in any event would be required for flushing, might be taken as *nil*, it was hoped that, subject to the introduction of all necessary and sufficient safeguards against possible risk of pollution of the water supply, the sanction of the Water Authority might be obtained to the proposed utilisation of the otherwise wasted pressure for a useful public purpose.

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DIAGRAM "B" SHR

VENTILATION, :R

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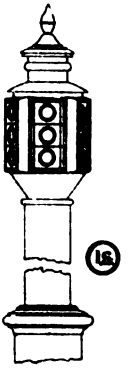

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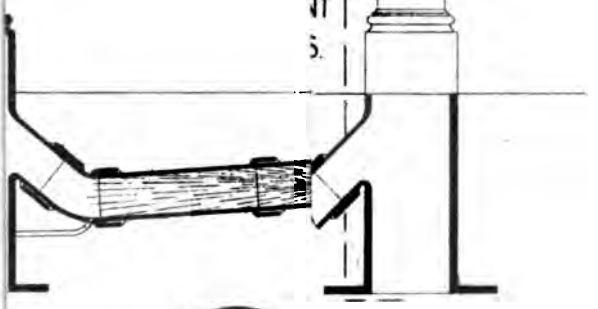

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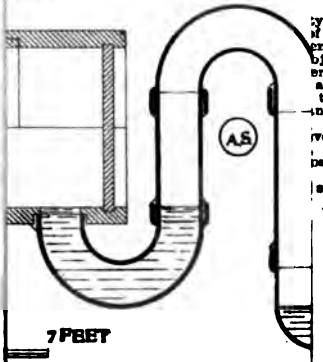

7 FEET

A.W. CROSS, A.M.I.C.E.

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Unfortunately, however, the Sanitary Authority and the Water Authority are not one and the same body at King's Norton as they are in probably nine out of every ten districts of equal size in the United Kingdom, so that, notwithstanding the safeguards, five in number (shown on Diagram A, illustrating this paper), each one of which, if in proper working order, should of itself be sufficient for the intended purpose, the wishes of the District Council in the matter were frustrated by the refusal of the Water Department to approve the proposal unless the Local Government Board first sanctioned the scheme, whilst the latter body, with their proverbial very extreme caution when dealing with any departure from the beaten track, declined to take the initiative. Each of the two Authorities, however, was fain to admit that the chance of any pollution was exceedingly remote.

The water-spray has for the present, therefore, been reluctantly abandoned until either some method to which the Water Department cannot object has been devised for utilising the pressure of the water without unduly impairing the efficiency or simplicity of the spray,* or until some sanitary authority, untrammelled by a water authority who admittedly have no interest whatever in a mere matter of health such as improved sewer ventilation, shall have demonstrated the safety of the system.

Diagram B (which with its notes will be sufficiently self-explanatory) has been prepared to show an arrangement of the water-spray extractor fixed at the base of a tall vent shaft, the waste water being shown as feeding a novel form of flushing tank very recently adopted at King's Norton, consisting of 24-inch diameter concrete pipes, and having an automatic syphon formed of ordinary stock pattern sanitary pipes and bends, and a specially made but inexpensive sanitary-ware trap.

The cost of the materials for a tank of 500 gallons capacity including the automatic syphon, tipper-box and a surface-box (which may be of light pattern as the tank is placed under the footway) should not exceed 12*l.* delivered free or only about half as much again as an iron automatic syphon alone without any tank, and it has the advantage over the latter of being non-corrodible throughout.

A sample of the concrete pipes used for the flushing tanks (with automatic syphon) may be seen in the court-yard of the Council House.

* Any suggestions as to this will be welcomed by the Author.

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A model (marked D) of a simple automatic arrangement adopted at King's Norton for the purpose of diverting the flush down two, three, four, or even more sewers in regular rotation, is also shown.

Experiments are about to be undertaken with a view of ascertaining what proportion of tall outlet-shafts to short inlet-shafts will give best results, as, obviously, too large a proportion of inlets to outlets may have a tendency, especially during gales of wind, to put an undue pressure on the water-seals of interceptor traps in house drains.

The Ventilation of House Drains.

It will occur to Members that the principle of sewer ventilation described in the foregoing paper—omitting the water-spray—is in accordance with the present practice of ventilating house drains, which consists of an air inlet having in the better class of work mica or aluminium flaps to prevent back currents, and an outlet consisting of an open vent pipe carried up above the roof.

There seems to be a growing desire on the part of municipal engineers to do away with the interceptor syphon in main house drains and simply have at the summit of each drain an open outlet of safe height which would assist in obtaining free circulation of fresh air through sewers and drains alike.

The Author is inclined to the opinion that this would certainly be a lesser evil than the interceptor which, in a properly constructed drain, appears to be the only likely cause of stoppage.

The desire to make house drains assist in the ventilation of the sewers seems in many towns to have led to the adoption of a regulation requiring a vent shaft to be connected with the drain on the sewer side of the interceptor, and carried up the front or side of the house.

It is possible that some day this practice may be found to have potentialities in the shape of claims against the Authority for blood-poisoning by sewer gas, though the probabilities are perhaps more remote than if the sewer were ventilated into a special flue forming part of a house chimney stack, as the Author understands happened in one case in King's Norton some years ago, and which cost the Rural District Council over 3000*l.*

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If house drains are to help in the work of sewer ventilation, what better method could be adopted than to do away with the interceptor, and make each house drain contribute its quota of fresh air to the sewer through a tall *inlet* shaft at the summit of its drains, carried up, if need be, above the adjoining roof, or at least sufficiently high to catch the wind from whatever quarter it might come, such shaft being fitted with a mica or aluminium flap non-return ventilator inlet similar to that described above, the sole duty of the Authority being to provide in suitable positions and in sufficient numbers along its roads and streets, tall outlet shafts with or without mechanical means of drawing the air from the sewers, and with or without means of purifying such air, whether by washing with water, scorching with fire, oxidising with permanganic compounds, or in any other way that may be found necessary or desirable?

To provide against stagnation when there is little or no wind, the cheapest and best air mover would seem to be the water-spray, which also has the further advantage, if fixed near the outlet shaft, of washing the issuing air; but it could equally advantageously be applied at the summit of house drains for the purpose of injecting air into and afterwards flushing the drains.

The right to use non-return mica-flap or other similar inlets, in combination with open-shaft outlets, or the two in combination with water-spray extractors discharging their waste water into the sewers or drains through automatic syphon tanks for flushing purposes, is not, so far as the Author is aware, protected by patent, as is the case with nearly all other systems embodying mechanical aids to sewer ventilation.

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VENTILATION OF SEWERS AND DRAINS.

By HERBERT H. HUMPHRIES,
Engineer and Surveyor to the Urban District Council of Erdington.

The Author particularly welcomes the idea of the proposed meeting of the Association to be held at Birmingham, to consider the one special subject of the "Ventilation of Sewers and Drains" only, feeling that its thorough discussion will be most useful to many of the Members, who like himself, desire to feel convinced of the best method of dealing with this much vexed question.

The views expressed in this short paper are based entirely upon experience gained in a modern residential suburban district, having a majority of its sewers constructed with small stoneware pipes, and where the residents are naturally very sensitive in regard to matters interfering with the amenities of their existence.

It is unnecessary here to describe the composition, etc. of the foul air caused by the putrefaction of sewage, but its undoubted relation to various diseases renders its safe disposal a matter of considerable anxiety, and the almost innumerable devices designed to this end, the great number of which are contradictory of each other, are bewildering. Most of these devices, which do away with open ventilation, do not do anything like the work that is claimed for them, with the result that, where adopted, false security is felt and thereby trouble may be occasioned.

The question as to whether the ventilation of sewers is necessary or not, is often argued, and as sewer air at a considerable majority of times travels with the current of sewage, the outfall of each system of sewers appears to be the proper place for extracting

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it. This means, however, a danger of the sewers becoming full of foul air, which is liable to be forced into the house drains, and great difficulty must be caused in storm time by the want of proper ventilation. One or two towns which have provided no ventilation to sewers have afterwards rectified this want, notably Dundee, the sewerage scheme of which town had no provision for ventilation, which has, however, since been provided by surface ventilation, owing, the Author is informed, to bad smells being complained of—at the rear of houses, he presumes—and the system adopted gives considerably greater satisfaction.

Though mechanical means of ventilating sewers are not generally successful, it will be both interesting and valuable to have the results of a practical trial of the method recently designed, of drawing fresh air through properly designed openings, through the sewers, by means of a fan, and discharging the sewer air at suitable points.

More attention appears to be given in many cases to the methods of the ventilation of sewers by elaborate and expensive means, to prevent complaints, than to means for modifying to a considerable extent the causes which render such methods necessary.

That these causes can be almost eliminated in many pipe sewers, which are well laid, with good gradients, is capable of practical demonstration, providing such sewers have their air currents disconnected from sewers from which the causes of the foul air are not easily removable; and it is not reasonable that foul air from a particular sewer should be permitted to spread throughout the system of sewers. Those sewers with a reasonable amount of sewage running through them, may, with good flushing and periodical inspection and cleansing, be kept in such a condition that surface ventilation may be adopted, improving further the conditions of such sewers, without vitiating the atmosphere so as to be a nuisance or a danger. For such sewers further ventilating arrangements are unnecessary, and there seems to be no system of ventilation which has so many practical advantages. It is also efficient at nearly all times, and it is rare indeed that observations can be taken in a sewer so dealt with without finding that some ventilation is proceeding, and in storm time such ventilation is particularly valuable as it relieves the air pressure more effectually than any other system.

Care in designing the sewers so that there shall be the least

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possible amount of disturbance to the flow in the sewer, at the junctions with other sewers, and the entire avoidance of splashing, is of importance, in preventing nuisance at the surface ventilators.

Some sewers, belonging to a system, in which a large quantity of sewer gas is evolved in consequence of insufficient flow, or owing to a large area of the inner periphery of the sewer becoming coated with slime, by the rise and fall of the sewage, which cannot be readily prevented, however well constructed such sewers may be, create too much nuisance if ventilated by surface ventilation only.

The alternative method to surface ventilation most generally adopted is the closing of the surface grids and the erection of high ventilating shafts, which take the smells further away and relieve air pressure to some extent; but in storm time they do not do so sufficiently, and further the most active means of ventilation in the summer months, caused by the variation in the flow of the sewage itself, is rendered almost inoperative.

There is always a great difficulty, especially in suburban districts, in obtaining assent to the erection of large ventilating shafts against buildings from the sewer, and shafts erected against the kerbstone, if many in number, are both unsightly and obtrusive.

The Author has found that a judicious combination of surface and shaft ventilation has been the best solution of these difficulties, the shaft, as far as possible, being placed at junctions of sewers and the lower ends of gradients, and other suitable points, and the surface ventilators at higher points, in order to act as inlets with the shafts acting as outlets; and though there are no general laws regulating the currents of air in sewers, they being subject to so many influences, they are found to act in that manner, generally speaking, there being more movement in the air at the top of the shafts to induce an upward current, while the surface ventilation is the readiest means for the admission of fresh air. At times, of course, they act in a directly contrary manner; yet, if there are sufficient of both ventilators, there are as a rule, not many complaints, while the sewer gets satisfactorily ventilated.

The deodorising of the sewer air at particular manholes has been tried by the Author, and when a strong disinfectant was used, complaints were made as much about the smell from them

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as from the sewer, and some of the devices for that purpose appear to retard ventilation.

Good gas lamp ventilators are undoubtedly useful for fixing at isolated points where it is difficult or undesirable to erect a shaft.

The abolition of the intercepting trap on house drains would be of the greatest and most necessary assistance to the ventilation of sewers, and would keep the sewage quite fresh instead of being fouled by continual half-decomposed discharges from private drains. Its abolition would, however, only be warranted upon thoroughly well constructed and otherwise amply well ventilated sewers, owing to the difficulty of discharging foul sewer air at a safe point at the rear of most houses, in consequence of the position of windows and chimneys, but in any case, until the laws are altered upon this matter, the intercepting trap has to be reckoned with.

The Author has only written this short paper to assist in the discussion of this very vexed question, and to point out various difficulties met with in attempting to solve it; and his conclusions point to the fact that with small sewers, instead of elaborate and expensive arrangements for the removal of foul air from them without nuisance, the cost is more satisfactorily spent in doing away with the necessity of such arrangements by reconstructing bad and foul sewers and in improved methods of cleansing and flushing sewers, and thus enabling simple ventilation to be adopted.

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VENTILATION OF DRAINS AND SEWERS ANCIENT AND MODERN.

By C. CHAMBERS SMITH,
Surveyor to the Urban District Council, Sutton, Surrey.

"The wind bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh or whither it goeth." Such is the impression gathered after reading through a number of statements in scattered papers on ventilation in general—and of drains and sewers in particular—which is dependent upon the variable and fickle movement and temperature of the atmosphere.

It is some fifty years ago since attempts at the ventilation of sewers were made in London; and although at that time considerable thought and attention were given to the question as to whether sewers could be ventilated in the same manner as mines, and several experiments were made, the idea was given up, and a notable authority pronounced that it was impracticable.

Spasmodic attempts have been made at various times and places, chiefly by connecting sewers to furnace chimneys, to induce currents of air to sweep through sewers with a more constant energy and direction than could be obtained by atmospheric influences only; but such attempts have, either through entire failure or meagre results, not attracted the attention of surveyors to the extent of their being generally adopted.

We have almost universally fallen back on the question as to whether open manhole covers or vent shafts should be adopted, or in some instances whether any ventilation at all should be allowed, with the notion that, if the sewer gases could be "bottled up" in the sewers, the difficulty of dealing with them would be obviated.

Many have been the tests of the movement of air in sewers, vent shafts, manholes, etc., amongst which may be mentioned those by the late Mr. W. Santo Crimp at Wimbledon, and by

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Mr. E. George Mawbey, a Past President of this Association, at Leicester; the conclusion come to by both these gentlemen being that the wind "was the factor requiring the greatest consideration in determining the arrangements and positions of ventilating shafts." Mr. Mawbey gives some diagrams of his tests which seem to show that temperature is also an important factor, and, generally speaking, when wind velocity is high, and the air temperature low, the greatest current through vent shafts is obtained.

The Author does not know, unfortunately, of any tests which show the length or capacity of the sewers which may be affected by a vent shaft, and it would be valuable information, tending to a better understanding of the subject, if, when ventilating tests at vent shafts were made, the volume of the air and the capacity of the sewer affected thereby were noted.

The Author assumes it will be granted that ventilation of sewers is necessary. "Bottling up" is impossible, as the sewer gases will find their way at some point or other into the atmosphere—so that the more perfect and constant the ventilation of drains and sewers is made, the better for the community.

The duty of dealing with organic refuse of all kinds is a necessity, and is not a very popular subject. We would all like to avoid the question as much as possible. But, by approaching the matter in a scientific way, much has been done in successfully treating liquid and solid refuse, and converting them into innocuous and harmless (and, in many instances, beneficial) products. It now seems to the Author that gaseous refuse should also be approached in a more scientific and methodical manner than has been done hitherto.

At the Sanitary Congress held in Manchester last September, at a meeting for specially considering the question of ventilation of sewers, some of the members went not merely to the extent of discussing ventilation *per se*, but so far as to discuss the question of treating the sewer air by cremation or by chemicals, so that the pathogenic germs and poisonous gases should be destroyed—no doubt an excellent proceeding, if it can be brought within practical limits.

Before such treatment of the gases can be attempted, however, it is absolutely necessary they should be brought under control both as to volume and place of exit from the sewer. This consideration brings us to the weak point of all methods of ventilating drains and sewers by utilising atmospheric influences

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only—namely, that in no such method can the volume of air or point of exit be controlled.

Apart from any question of treating the issuing sewer gases, the control of the volume and direction, as well as the choice of a place of exit, are important matters as regards ventilation of itself, and any method which gives such control and choice is based upon correct principles.

The Author considers it hopeless to obtain control if atmospheric influences alone are depended upon, and he is driven to the conclusion that mechanical means must be resorted to for efficient ventilation of drains and sewers, notwithstanding the apparent failures resulting from attempts at such means in the past.

The "Shone" system, introduced by Messrs. Shone and Ault last year, seems to promise success in the direction referred to, inasmuch as the authors have approached the question in a scientific manner, and in a way which has been influenced by their long practical acquaintance with coal mine ventilation. This system, simply described, is a means of extracting air from drains and sewers by a fan driven electrically or otherwise, and the controlling of all air admitted to the drains and sewers by openings regulated in diameter in accordance with the volume desired to be admitted at any one point, and the vacuum available at that point.

By such means it is claimed that fresh air is admitted at a soil pipe or interceptor, drawn down the house drain, away to and along the sewers to the fan and thence up a vent shaft (in a chosen position) into the atmosphere. The volume of air admitted can be proportional to the sewage flow, or in other words, to the population served. The authors of the system state that one-tenth of a cubic foot per minute per inhabitant will give an excellent dilution; and, basing a comparison on some analyses of sewer air by Dr. Letheby, the CO_2 would be increased from the normal of 4 parts per 10,000 in the outside atmosphere to $4\frac{1}{4}$ per 10,000 in the air issuing from the vent shaft.

As a trial installation will be completed and tested at Leicester in a short time, and another installation completed at Darley Abbey, we shall soon know whether Messrs. Shone and Ault are justified in their claims. If they should be, a great step in the efficient ventilation of drains and sewers will have been reached.

In conclusion, the Author would point out that, as regards the after-treatment of sewer air, the regulation of the admission of

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air to the drains and sewers is a means of keeping down the volume of air to be treated by cremation or otherwise within reasonable limits.

DISCUSSION.

Mr. J. PRICE: I have pleasure in proposing that a hearty vote of thanks be accorded to the authors of the papers. I have seen Mr. Cross's apparatus at work in his own district, and I must say I was surprised to see the large volume of air passing through the pipe caused by the induced current resulting from the water-spray. The question of cost must always be borne in mind with any system of ventilation. If you design a system of sewers which cost 10,000*l.*, then you add on 5000*l.* for ventilation, you are doing something that will seriously jeopardise, if not stop, the progress of sewerage works in the district. With reference to the table on p. 166, giving the death rate for a period of ten years of the great towns. That table does not to my mind seem quite complete, unless the density of population is put to each of those towns. When you examine the figures relating to Birmingham, Manchester, or Liverpool, you will find the density is about 41 or 42 per acre. But when you examine the figures for Leeds and Sheffield, which are equally manufacturing towns, you will find that the figure drops from 42 to about 18, and you will see the reason of the variation in the death rate. It may be taken as an axiom that the death rate varies according to the density of the population.

Mr. J. PARKER: I have only had time to read four out of the six papers: Bristol, Gloucester, Worcester and King's Norton. The writers agree that the old system, by open gratings at the street level, is a failure; the majority give a modified approval of ventilator shafts with outlet and inlet openings, and here the real points of divergence begin, proving once more how easy it is to discover a fault and how difficult to provide a remedy. Bristol says practically "all known systems of satisfactorily dealing with sewer gas are inadequate, therefore bottle it up." I totally disagree with this view and could give good reasons if time permitted, but I must pass on. Mr. Caink gives us an interesting paper, his views are very clearly set out and there can be no doubt that he is on sound lines, but so far the use of disinfectants and filters, while preventing smells, has, I fear, been on the principle of "bottling them up." Mr. Cross

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divides his subject into three categories: I pass on to the third, where the points of divergence begin. We are at one in the opinion that unaided or natural means are inadequate for the ventilation of sewers. The parting of ways may be summed up in the different values we respectively entertain, of the two elements as aids to ventilation, fire and water. In the destruction of noxious matter, I am a firm believer in the former, and in this I am following the teachings of the first sanitary engineer on record, Moses, who was also a water-works engineer, but history does not tell us what he thought of the water-spray. I have had twenty-five years' continuous experience in the management of sewers and water-works, and have put to practical tests every ventilator which is, or has been commercially before the public except the "water-spray," and have not the slightest pecuniary interest in any. Therefore I approach this subject entirely free from bias. I am entirely out of sympathy with the Author in both his arguments and his conclusions. My objection to this invention is that without the water-spray the method is costly and complicated, and with the water-spray it is absolutely impracticable. Air inlets or outlets which depend upon the correct action of either mica or aluminium valves are, for reasons stated in Mr. Read's paper, absolutely unreliable: the invention has thus all the defects of the shaft system without its economy. As to the Author's proposal to use the water-spray in the way suggested as a motive power to promote sewer ventilation, in the interests of the water-consuming public of King's Norton I at once enter my most emphatic protest against it. The Author has *on paper* prepared five so called safeguards against the contamination of the public water supply. It appears that the district council were frustrated in their wishes to adopt the "water-spray," notwithstanding these safeguards, by the refusal of the water department to approve of the proposal to connect to their mains, and in this the water authority was supported by the Local Government Board. The Author adds, "Each of the two authorities was fain to admit that the chance of any pollution of the water was very remote;" this, however, was to my mind only a polite way of expressing their disapproval. Speaking as a water-works engineer, I am *not* fain to admit anything of the kind, on the contrary, the possibility of fouling the mains under a high pressure service is *not* remote under the circumstances, and I should promptly refuse to allow any such connection with the water supply under my charge. Their experiment

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in sewer ventilation by a house chimney some years ago appears to have resulted disastrously in the loss of at least one life and an expenditure of 3000*l*. What the cost would be in life and money if such connections as are suggested were made with the water supply, it is difficult to estimate. The risks attending such connections are great—indeed the modern rules and regulations as to water supply forbid such a connection. It is a matter for regret that the Author has been unable to extol his own scheme without reflecting upon a rival invention, which has at all events the merits of having passed the experimental stage. I have not seen the pamphlet to which the Author refers on p. 174, but have written for a copy, and I shall be much surprised if it affords any basis for the ludicrous colouring with which the Author has clothed it. I refrain from mentioning the name of the firm to whom he refers, but there are many Members of this Association who, like myself, have extensively used, and are still using, and are satisfied with the apparatus, there being some 150 cities and municipalities at home and abroad in which it is now in use. I regret to have to refer to this part of his paper, but such remarks are unjust, both to the makers and users, and if the Author's conclusions as to this invention are correct all the officials responsible for its introduction are either foolish or extravagant. I deny that we are either one or the other.

Mr. E. B. SAVAGE: I cannot help being struck with an important point which in some of the papers has not been touched upon and in others but very lightly. I refer to the necessity of ascertaining the causes and nature of the trouble with which we have to deal before attempting to prescribe a remedy. My reason for urging the importance of this is that it appears to me that sewer emanations (leaving out those cases due to special causes) are of two entirely distinct origins, viz. (1) those due to putrefactive changes in the sewers; and (2) those due simply to the foul-smelling liquids and excreta passed into the sewers. Let us take, for example, the sewers of this city where we have upwards of 350 miles from 9 inches to 7 feet diameter, working under almost every conceivable condition. Many of these were constructed upwards of forty years ago and were not always laid to true gradients, consequently accumulations of deposit occur. On this being allowed sufficient time for decomposition to set in, what may be justly termed "sewer gas" is thrown off, but it is a curious fact which perhaps other engineers

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present will bear out with me, that it is not from such sewers that the worse complaints are received. From this it can only be inferred that what are undoubtedly the most poisonous gases are not those which are most frequently brought to our notice. Take now the small sewers more frequently adopted in the outlying portions of this and other cities. The majority of these are of more recent construction, and have been laid with good self-cleansing gradients. From the statistics I have kept for many years I find these are the sewers which have given rise to by far the greatest number of complaints. In considering what remedy to apply, what have we? in the first case, a defective sewer in which putrefaction is taking place; in the second, a clean sewer free from deposit but giving forth (particularly on Sundays, when more cooking is done) most offensive smells. Clearly reconstruction is the proper remedy in the first case (or failing this, continual flushing); but as regards the second, why should we go to the expense of costly systems which aim at destroying by cremation, chemicals or other means the germs of disease so popularly assumed to be associated with such foul smells, but which, I venture to think, exist more in imagination than in reality? It appears to me that the problem which the engineer has to solve is a comparatively simple one, viz. to so provide vent openings that the smells pass away into the open air without the possibility of their being blown into dwellings or being otherwise offensive. The portion of report of the Borough Engineer of West Ham quoted by Mr. Cross puts the case before us, I think, in its true light. As regards the system of ventilation adopted in Birmingham, after having tried various costly systems we still find that the vent pipes placed in judiciously selected positions, used in conjunction with a reduced number of open gratings, give the best results. We have at the present time about 80 of these shafts and are continually adding to them, and it may be interesting to note that within the last five years we have been asked to remove two only, and in one of these instances the tenant has since expressed a desire to have it refixed, so great was the benefit derived from it. In other districts where formerly it was almost impossible to pass along the streets without noticing the smells, wherever shafts have been erected complaints have almost entirely ceased. I am also glad to say that the public are now appreciating these facts, so that nothing like the same difficulty is being experienced in obtaining consents to their erection as formerly.

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Mr. W. WEAVER: We have before us six papers, four taking one view, and the remaining two papers taking virtually the opposite view of the question. The remarks of Mr. Savage, are very apropos to the subject. You have got to consider what is the nature of the difficulty you are dealing with. It is very common to describe the emanations from sewer vents as sewer gas: but as a rule, it is nothing of the kind: it is simply sewage smell, and there is a vital difference between the two. In properly constructed sewers there is no sewer gas, only sewer smell. There is nothing injurious to health in that. Borough surveyors will agree with me that the healthiest men on their pay sheets are the men who work in the sewers. If sewer smells are so bad, how is it these men live so long and are so rarely on the sick list? This question of sewer smells has been before the Local Government Board and the London County Council for the last twenty years, and they have had the best advice and engineering skill that money could procure. The result is they resolved first that the sewers should be properly constructed, and second, they should be kept clean and provided with a current of air passing through them. The question is how to get a current of fresh air through the sewers without offending the noses and causing complaints from the people passing along the streets. If I were laying out a model town, I would not have a single syphon trap on any of the main house drains included in the system, and then I should expect to have a constant flow of fresh air through the sewers. But we have got the syphon trap, and it has come to stay with us. When I read my paper before the Society of Medical Officers in 1875, when syphon traps were first introduced, soon after the illness of the Prince of Wales—which illness also gave birth to the sanitary expert, who has also come to stay—the panacea for all the ills was somebody's patent syphon trap, the aim of which was to cut off the drain from the sewer. I am quite at one with Mr. Read and the four other writers of papers that the syphon trap is a great mistake; but all the same it has come to stay and the question is what is to be done to remedy the present state of things. Mr. Price has touched upon an aspect of this question which must not be lost sight of—the cost of ventilation personally. I would rather die at 50 and have something to eat every day, than live half-starved to a hundred. When you find rates at 10*s.* in the 1*l.* it is time to consider these

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matters. When a young married couple take a house at 30*l.* a year, and they find the rates come to another 15*l.* a year, it makes a difference. Mr. Caink seems to advocate—in a measure—the bottling up of the smells in the sewers and the filtering them through a respirator. Of course in some exceptional positions that might be advisable. Four of the writers entirely agree as to the unwisdom of syphon traps. In the paper I have referred to, I said the syphon trap would provoke more ills than it would cure. Dr. Alfred Carpenter, who was then Medical Officer for Croydon and a well-known authority in sanitary science, insisted that whatever tended to interfere with the flow of sewer air was not a proper system of drainage. We had a meeting of all the engineers of London two years ago, presided over by Sir Alexander Binnie, who convened the meeting, to consider what should be done to meet the difficulty of sewer smells in London. We were entirely at one in objection to the syphon trap, but looking to the complication of old drainage and so on, we could not recommend the abolition of syphon traps on the drains, unless the whole of the drainage was reconstructed. But we recommended that wherever a syphon trap was inserted, the householder or whoever was doing the work should put up a ventilating pipe on the sewer side of his interceptor. I am sorry to say that our recommendations when sent round to the local authorities did not find acceptance, so we in London were thrown back upon ventilating pipes wherever we can fix them. With all the difficulties and perplexities of the case that is the best thing to be done under the present circumstances. Close up as many of your surface gratings as possible and put up your extracting shafts in whatever positions may be suitable. That is the only thing that can be done with the sewer ventilation question in London. I have fixed several hundreds of these shafts, and when I began using them I put on different kinds of patent cowls and so on, and kept records of the air extracted. I got a great variety of readings, and the only thing I established to my own satisfaction was that the pipes worked better without cowls than with them. I put a wire guard or dome on the top of the shaft to prevent the intrusive sparrow building nests and so on.

Dr. W. F. DEARDEN (Chairman Manchester Corporation Special Committee on Sewer Ventilation): We, in Manchester, are very much interested at the present moment in this great

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question of sewer ventilation, and my presence among you indicates that I look upon this as a most unique opportunity for hearing important and reliable opinions upon the subject. Several gentlemen have dealt with the subject from the point of view—what have we to ventilate our sewers for? I think that is really the crucial question. Before we start engineering works we should know what those works are for. We, in Manchester, are starting our experimental work from that point of view. We do not know yet what the effect of sewer air is, and it is of primary importance that we should know. Strange to say, the conclusions drawn in the report of Messrs. Parry, Laws and Andrews were quite contrary to the ideas possessed by the majority of engineers. Those observers drew the conclusion that the air of sewers instead of being worse was better than the air of the streets above them. One or two gentlemen have made later experiments on this question. Dr. Arthur, of King's College, and Dr. Nash, Medical Officer of Health for Southend, have taken up the question, and certainly appear to have proved that dangerous germs can be obtained from sewer air. The natural question is, if there is nothing injurious in sewer air, why should we go to the expense of ventilating the sewers? We know in Manchester it would cost 200,000*l.* to 300,000*l.* to ventilate our sewers on any known scientific plan, and as long-suffering ratepayers we want some good reason before we embark upon that expenditure. We have therefore decided to let the engineer have a little rest and are seeking aid from the bacteriologist. We have given instructions to Professor Delepine to take up the question of sewer air, and the relation it bears to the health of the people, and I have no doubt we shall in due course be able to publish some definite conclusions as a result of his investigations. In addition to the bacteriologist we are utilising the chemist and electrician. Besides conducting these scientific researches we have decided, having very open minds on this question, to try the system of Messrs. Shone and Ault, and are also going to give a fair trial, by putting down experimental plants, to other systems. I hope our various experiments will prove valuable stepping-stones in enabling us to arrive at some satisfactory solution of the problem before any great lapse of time. I have been very much interested in the papers, but am, at the same time, rather surprised to find that the majority—four out of six—have got

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the idea that the proper way to ventilate sewers is by utilising the ventilating shafts on the house drainage systems. I may say that is not our idea in Manchester; on the contrary, we think we have good grounds for sticking to the dual system. The terrible tale told in one of the papers of the fearful condition of the intercepting traps on house drainage systems makes one almost wonder how one can, in face of such dangers, be alive to-day. That experience is not the general experience in the North. We profess to be pretty good at house drainage work, and when, as often happens, a system is opened up, instead of the traps and pipes being receptacles for filth, they are mostly found in a very good condition. Indeed, it is no exaggeration to say they are often as clear and clean as when they were first put down.

Professor BOSTOCK HILL: The report of Messrs. Parry, Laws and Andrews has been mentioned to-day. I think, as sanitarians, we have suffered from that report. It was drawn up with reference to the London sewers. The London sewers exist under different conditions to the malodorous sewers in small towns. The sewage in the London sewers is constantly running; they are large and we should not expect the same condition as regards bacteria in the sewers of small towns. When a sewer smells, it is evidence of putrefaction. Gas is formed, and the bubbles of this gas burst and take up into the atmosphere micro-organisms in the sewage, and danger results. Therefore, we ought not, in all cases, to conclude that there is no danger—as was tried to be proved. Sewer gas may be very dangerous if it is confined in a limited space. If the sewer gas gains access to a house, disease may ensue; but where it comes out into an open street there is certainly much less danger. I should say that from an experience of twenty-five years' consideration of this question that opinion is backed up by the report of Dr. Bruce Lowe. As a result of very prolonged investigation, Dr. Bruce Lowe was able to prove that offensive sewers were scarcely ever associated with zymotic disease. I had an experience of the same kind myself. In a neighbouring town we had an outbreak of diphtheria, some twenty-five cases and about twelve deaths. There were complaints of smells from the sewers, and an outcry was raised that the smells were the cause of the disease; but when the cases were investigated it was proved that the deaths were in the non-sewered part of the borough, and the sewered part was free from the disease. As to mechanical

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forms of ventilation, I must say I am not hopeful. The suggestions which have been made of heat and other mechanical means seem to have so many difficulties that I do not think we are likely to get a solution of the question in that way. Neither am I sure that anything is going to be done in the way of disinfecting sewer air. The use of disinfectants cannot produce anything proportionate to the trouble and expense entailed. A word as to the intercepting trap. The intercepting trap is not beloved of engineers. I do not altogether wonder at that, as it is a nuisance to the engineer. It keeps the sewage back and causes difficulties which have to be overcome, but I think at the present time we have evidence that it is undoubtedly dangerous to allow the gas from sewers to escape over houses. If we could always be sure of a certain amount of wind to diffuse the air from these pipes there would not be much danger, but we know, particularly on autumn evenings, when the gas comes out possibly laden with bacteria, and the air becomes cooler, it falls down the chimneys into the houses, particularly if there is no fire in use, and there is considerable danger to the health of the people if these intercepting traps are not used. I am inclined to think at the present time, though it is not a very scientific state of affairs, that the putting up of ventilating shafts (up the sides of houses only in exceptional circumstances) together with the closing of as many as possible of the surface grids, is the best way out of the difficulty. I would also protest against the multiplication of interceptor traps where the houses are separately drained, as these, when too numerous, not only obstruct unduly the flow of sewage, but materially interfere with the proper ventilation of the drains.

Mr. E. J. SILCOCK: I am very pleased to have heard the remarks made by Dr. Hill. They have been extremely interesting, not only to me but I have no doubt to every Member present. This seems to me to be a subject on which there is a great deal of difference of opinion, but if there is one part of the subject upon which everyone is agreed, it is, that of all the causes which affect the movement of sewer air, there is none to be compared with the effect produced by the wind. I think everyone who has taken any observations with the anemometer will agree. That effect seems to me to be one upon which too much stress cannot be laid, and it should be borne in mind in discussing the subject more than anything else. With regard to

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the question of the intercepting trap, the fact that certain sewers emit smells has been pointed out by Dr. Hill to be probably due in large measure to the fact that those sewers are conveying sewage in a septic state. Anything which retains the sewage, or retards its flow, must be adding to the quantity of sewage in a septic condition, and therefore adding to the smell. That is a very strong argument in favour of the abolition of the intercepting trap. I am one of those who favour the abolition of the intercepting trap. I think the sewer and the drain should all be treated as part of the same system, and as every drain contributes its quota towards the smell, so every drain should contribute towards the removal of that smell. An arrangement of inlets and outlets with flaps attached to them is, to my mind, open to grave objections. I have never yet seen anything in the way of a mechanical flap which would maintain itself in proper repair for any time. Whether the one described by Mr. Cross will do so remains to be proved by time. I quite agree with the opinion expressed by Mr. Weaver that an open pipe with an ordinary wire guard is quite as efficient a ventilator as anything we can obtain by a flap, or a mechanical ventilator. As far as one can see, the best way of dealing with the question is to do away with the intercepting trap, to close all the surface grids, and to have as many high shafts as possible with perfectly plain open ends, to keep them as far away from the buildings, to have as few complications and connections with the sewers, to avoid as much as possible all bends, and make the route to the air as direct as possible. These appear to be the means by which one is likely to obtain the most success.

Mr. T. de COURCY MEADE: I had not intended to take part in the discussion this evening, but hearing so many of our friends expressing opinions against intercepting traps, I felt I could not go back to Manchester without giving you my views. I have had the question of the ventilation of sewers continually before me since 1875. When we commenced the ventilation of drains apart from the sewers, we had a large intercepting trap with a cleaning eye in the bend, which was a great nuisance. But the intercepting trap in use to-day is not liable to foul if properly fixed in drains which have the ordinary fall. In Manchester we have thousands of the improved type of intercepting trap, and get very few complaints. In some portions of the city, where there are small cottages, there are no

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drains inside the house; the closet is placed in the yard at the back of the premises, and drains direct to the sewer in the passage at the rear, and in some cases the trap is placed upon the passage drain, which is ventilated by a shaft at the top end. In dealing with the ventilation of the sewers of a large manufacturing city like Manchester, many difficulties are met with which are not found in towns having a purely domestic sewage. In Manchester there are a number of chemical works which discharge refuse into the sewers, and we have complaints of gases from the sewers which receive chemical refuse passing into houses through the traps of unventilated drains. In cases of that kind special arrangements are necessary, and if the intercepting trap were abolished the dwellings would become uninhabitable. It is interesting to note the effect of these foreign gases, because you have them in a concentrated form. If you depend on the ordinary water-closet with one trap, even in a district where there is no chemically charged sewage, you will still have the sewer gas playing on the water on the sewer side of the trap, and that trap is the only safeguard you have between the interior of the house and the sewer. I think it is to be regretted that younger Members and Graduates who are present to-day should hear so many seniors propose the abolition of the intercepting trap: it is a very dangerous principle to advocate, and I have risen simply to enter my protest against it: it is unscientific, and it is not the remedy for unventilated sewers.

Mr. W. HARPUR: I had not intended saying anything upon this question, but there are one or two peculiar conditions in the town of Cardiff, which may be of interest to the Members. My chief reason for speaking is the remarks made by Mr. Steele, for one would have thought the unfavourable situation of Cardiff, particularly in its near approach to sea level, would have caused the town to stand in a much worse position than it does on that diagram. The town lies very low: about thirty per cent. of the built-upon portion is below the level of equinoctial tides, consequently for four hours out of every twelve the sewers are tide-locked. There are large main trunk sewers running up to 10 feet diameter, acting as a reservoir for the sewage during the tide-locked periods. All the sewers are large; we have no small pipe sewers. They run from 10 feet diameter down to 3 feet by 2 feet egg-shaped. The gradients are bad, running from 1 in 2000 to 1 in 200—the latter is considered a very good gradient.

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The sewers are made large, because with such slow gradients, good self-cleansing sewers cannot be expected, and they are made large enough to be traversed by sewer men for the purpose of removing any deposits and silt that may take place. Notwithstanding this, Cardiff has been freer from smells from the sewers than most towns. That confirms the fact mentioned by Dr. Hill that sewer gases are more easily detected and more frequent from small pipe sewers than from large brick sewers. We have the open street ventilators, and the complaints are not so serious as in most towns. One would expect most complaints in the low-lying districts where the sewers act as tanks. In the districts which are on the higher level, I have found the best remedy for sewer smells to be the introduction of automatic flushing tanks. We have about seventy of these tanks, each of a capacity of 2000 gallons. I placed in them a large size Austin's porous cell charged with permanganate of potash. Immediately after the discharge of one of these tanks I have found the nuisance has been abated. Dr. Hill said he did not believe in attempts to disinfect sewer gas. If you deodorise in this way it kills the smell from the sewer, and I have found it an almost instantaneous cure for anything of the kind. The smells no doubt arise more particularly in dry weather when the flow of sewage is small, and where in large sewers the flow of water is not sufficient to carry off the solid particles. As soon as I put one of these tanks in operation it has invariably proved a perfect cure, and where similar conditions exist, I can strongly recommend their use to my brother engineers.

Mr. N. H. Dawson: Referring to Mr. Read's paper, I entirely agree with him that "ventilation is necessary to provide for the escape of the air displaced by the rising sewage, or the air would be under compression and would force any traps which might be inserted for keeping it in the sewers, and the longer the time required to sufficiently compress the air to force the traps the worse would be the final result." Again I agree with the remark that "the remaining systems are altogether too costly for general application, although they are occasionally useful for isolated cases of offensive manholes to avoid the expense of a reconstruction." I think the remarks this afternoon have tended to confirm that view, that the doing away with open grids in the streets and the putting up of shafts is the simplest and best method of ventilating our sewers. Again, at the

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conclusion of Mr. Read's paper he says he "would like to try an experiment by omitting the interceptor trap on all drains which are outside the houses." I am very glad that the majority of those who have given expression to their opinions this afternoon have been in favour of doing away with the interceptor trap—if not altogether, at least to a large extent. With regard to Mr. Cross's paper, he says that "as regards the systems in the first category, open gratings at street level are equally unsatisfactory, whether they be numerous or few, whether they be open and unobstructed, or have filters of any kind to offer resistance to the free circulation of air through the sewers." With that I agree. We find continually nuisance from these open grids in the streets. In Reading we tried gas destructors, but they are very expensive and not completely successful. I think the doing away with the grids and putting up shafts is a sufficient remedy, provided the shafts go well above the house chimney tops.

Communicated Discussion.

Mr. R. M. Gloyne: Some years ago I fixed at Eastbourne half a dozen of the apparatus described by Mr. Caink, and have had no complaints afterwards respecting the particular manholes in which they were placed. An objection to the arrangement is that it cannot be fixed in shallow sewers. As long as the "model" bye-laws are in force the abolition of the intercepting trap as proposed by Mr. Read is practically impossible.

Communicated Replies to Discussion.

Mr. A. W. Cross: Before replying to that part of the discussion which refers to my paper, I should like to express my grateful appreciation of the resolution of thanks so cordially voted to the readers of the papers to-day. In dealing seriatim with the remarks and criticisms passed on the system of sewer ventilation described in my paper, I have first to thank Mr. Price for his valuable testimony to the effectiveness of the water spray as a sewer air extractor, and I can only regret that

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he did not see his way to express an opinion on the sufficiency of the safeguards suggested for the elimination of risk of pollution of the water supply. On this latter question I shall have something to say in reply to the remarks of Mr. Parker, City Surveyor of Hereford, who I am sorry to find has taken my allusion to the tendency of patentees and manufacturers of proprietary systems to exaggeration when advertising their wares, so to speak, as having a more personal application than I intended. At the same time it will never do to admit that because, as he says, many Members, including himself, have used a certain proprietary system, it is unfair to such Members to reflect upon the methods of advertising (for that was the sole subject of my criticism) such system. One might as well say that in any paper on sewage purification, it would not be fair when speaking in favour of the bacterial process, to reflect on the "lime process" or any of the other vanishing processes because there might be Members who had identified themselves with one or other of such processes. When Mr. Parker has received the pamphlet which he says he has written for, I commend to his consideration a statement therein that the patented system which it advertises and to which he pins his faith, *has displaced every other known method of sewer ventilation*, and let him ponder on the lacerated feelings of the hundreds of engineers and surveyors who have identified themselves with one or other of the displaced systems. As I say in my paper, the system therein described is, so far as I know, not a monopoly, and anyone may freely use the simple and inexpensive form of water spray, a model of which has been shown in the courtyard and demonstrated to be capable of moving 400 cubic feet of air per gallon of water, at 80 lb. static pressure. Anyone may also without royalty use in combination therewith a simple form of automatic syphon flushing tank as well as controlled air-inlets with mica or aluminium non-return flap valves. There were, I believe, patented forms of water spray on the market more than eight years ago, and in the maker's catalogue I find it is claimed that an efficiency of 1000 cubic feet of air moved per gallon of water is obtained. From my own experiments, however, I have not yet found any form of spray to give a better efficiency than the one shown in the courtyard. We also have the choice of several forms of controlled (valve) air-inlets some of which are not, I believe, protected by patent, and it is a matter

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for consideration in individual cases whether any of the patented inlets have sufficient advantages to make them worth the extra cost, if any. Turning to the all-important question of the sufficiency of the five safeguards which in the diagram are suggested to prevent the risk of sewer air finding its way back into the water service, in the event of the water mains being so rapidly emptied as to cause a partial vacuum and the consequent sucking in of air through the service pipes, I claim to have given this question as careful and intelligent consideration as Mr. Parker. I might be overawed by Mr. Parker's statement that he has had twenty-five years' experience in the management of sewers and water-works, but for the fact that I have myself been continuously engaged since May 1877 as head of similar departments. Has Mr. Parker's concern in the matter of the risk of tainted air getting into water mains and services ever led him to consider what appears to me to be a real (not imaginary) risk of such pollution, viz. the direct connection of water services to water-closet buildings? It is not difficult to imagine the possibility of the foul air being sucked into the water mains in the event of the one safeguard between the closet and the main (which in many towns consists merely of a stop tap with loose valve) not being proof against the sucking action set up by rapidly emptying water mains, and, personally I often wonder what the result might be in the event of such suction drawing in air through the ball valve of a water-closet cistern during or immediately after use, say, by a more or less convalescent typhoid patient. In my opinion there is absolutely no comparison between the risk, not to say danger hinted at above, and a water spray with its five safeguards fixed as shown in the diagram illustrating my paper. At the same time knowing that "two blacks do not make one white," I am content to leave the question of utilising in aid of sewer ventilation the immense power which has been proved to be latent in the flushing water (which power is now wasted), to stand or fall on its merits; but I ask that something more tangible than mere general criticisms, such as Mr. Parker's, should be advanced against it before it is dismissed as "absolutely impracticable," whilst his contention that it is "costly and complicated" is equally unsupported by facts or figures. Several speakers were good enough to refer to the special form of aluminium flap inlet ventilator-head adopted at King's Norton,

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and expressed the general opinion that any form of mica or aluminium flap valve had usually been found to give trouble by its liability to become ineffective after it had been some time in use, and no doubt these speakers had in mind the difficulty and expense usually attending the repair of the valves. It was with the full knowledge of these defects that I adopted the form of inlet head shown and marked C, and I think it will be admitted by all who examined it that owing to the method of suspending the flap valves, their repair in case of necessity is simplicity itself; and as to the cost of renewing a worn or broken valve, the price of the aluminium flap is about twopence, and the time required to take a defective one out and replace it by a new one is a small fraction of a minute. Dr. Bostock Hill doubted whether mechanical methods of sewer ventilation were on the right lines; whilst Dr. Dearden of Manchester I believe said that opinion in his city seemed to be veering round to the belief that after all sewer ventilation was perhaps more a question for bacteriologists and chemists than for engineers; at the same time I understood him to say that the latest and probably the most mechanical of systems, was about to be tried in Manchester. In conclusion, I should like to say that the system which I have endeavoured to explain to you and part of which is in successful practical operation, whilst part has perhaps only been demonstrated as effective in the experimental form shown in the courtyard, is an honest attempt, however crude, to adapt and direct, with the simplest mechanical aids possible, the natural force contained in water under pressure, and the natural force offered freely to us in every breeze that blows, for the "use and convenience of man," and I trust the day is far distant when any Member of this Association (and more especially does this apply to the younger men) who may be desirous of offering to the free use of his fellow Members the results of any system, process or contrivance—perhaps after having given thereto much time, thought and experiment—will be turned from his purpose by the fear of scathing criticism from Members who may have identified themselves with other methods.

Mr. STEELE: The impression formed after reading the papers and hearing the discussion, is to confirm one's conviction that Bristol would be ill-advised to alter its prevailing practice at the present time. Nothing that we have heard has, to my mind,

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established either of the fundamental principles that it is necessary to admit atmospheric air to sewers or to provide special means of exit for the air in them, at least so far as Bristol is concerned. One finds it difficult to agree with the view that special means are not necessary to deal with sewer air emitted into the streets and which causes objectionable smells though not dangerous to health. If any work for which we are responsible is objectionable to the inhabitants of a town, it is our duty to attempt the removal of that objection. It has been said that ventilation is necessary for the escape of the air displaced by the rising sewage, or such air would be under compression and thereby force the drain traps. Does the air ever become so compressed in a large sewerage system as to cause this? If it does, it certainly should happen in Bristol where on every spring tide there is a head of water against some of the outfalls exceeding 15 feet; observations are being made to ascertain if this does occur.

Mr. CAINK: I thank Mr. Gloyne for giving us the result of his experience with my ventilators. The only faults he appears to find with them are: (1) that they are complicated, and (2) that they cannot be applied to very shallow sewers. With regard to the first of these objections, a thing may be complicated in various senses. A machine may be complicated in the sense that it contains a large number of mechanical contrivances whose actions are dependent upon one another: those contrivances may be simple and their purpose obvious, as in a watch or a pianoforte, or they may be complex and their meaning difficult to follow. Another appliance may be complicated in the sense that it is difficult for the average person to follow the operations going on within it, yet the apparatus itself may be simple in construction and may need neither understanding in order to make use of it nor any attention to keep it in order. A stationary transformer may be instanced as an illustration of this kind of complication. The construction is comparatively simple, but the considerations involved in its design are complex enough, yet that constitutes no hindrance whatever to its use, and as there are no moving parts it requires no attention. It is only in this sense that the term complicated can be applied, if at all, to my ventilator. The appliance itself is simple, if the considerations which led to its design are not,

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there are no moving parts, and it requires no more attention than the occasional emptying of the dirt box under the surface cover and the periodical changing, about once in three months, of the cotton wool. With regard to the objection suggested by Mr. Gloyne that the ventilators cannot be applied to very shallow sewers, the depth of the entire apparatus is 4 feet 10 inches. If a sewer is so shallow as not to be capable of receiving it in the line of sewer, it is only necessary to sink a shaft at the side and convey an air pipe from the top of the sewer to such shaft.

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METROPOLITAN DISTRICT MEETING AT WESTMINSTER.

March 27, 1903.

Held at the Westminster Palace Hotel, Westminster.

MR. T. H. YABBICOM, M. INST. C.E., PRESIDENT, *in the Chair.*

THE minutes of the last Metropolitan District Meeting were read, confirmed and signed.

Mr. J. Rush Dixon (Shoreditch) was unanimously re-elected as Honorary Secretary for the Metropolitan District.

The following subject was then introduced and discussed:—

WOODEN STRUCTURES AND THE POWERS OF METROPOLITAN BOROUGH COUNCILS WITH RESPECT THERETO.

BY J. PATTEN BARBER, M.INST. C.E., BOROUGH ENGINEER, ISLINGTON.

THE powers and duties of the London County Council under sec. 84 of the London Building Act, 1894, with respect to wooden structures were transferred to the Metropolitan Borough Councils by sec. 5 of the London Government Act, 1899, and while designated in the second schedule of that Act "minor powers and duties," their exercise has brought great responsibility on borough councils and their engineers.

In advising his council respecting applications for licences for the erection of wooden buildings, stands, gantries and other wooden structures, the engineer has to consider the danger from

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fire and from the loads which the structures will have to sustain. Simple as an application may seem, there are very serious questions involved in it for the officer responsible for advising upon it, both in examining the plans and detail drawings and in inspecting the structure during its erection, and again at the expiration of the licence in case of application for renewal. It is to be feared that persons applying for these licences do not understand the responsibilities resting on borough councils and their engineers in connection with these structures, and that they regard their requirements of detailed drawings showing accurately and fully the mode of construction, and the situation of the structures with respect to neighbouring buildings, as faddy and unnecessary. Should disaster occur, however, the authority and its officer would be the foremost to receive blame and condemnation, and the loudest clamour would be made by those who expect that rough and ill-considered plans are sufficient to enable anyone to arrive at a complete understanding respecting a proposed structure.

In view of the risk of fire being communicated to and from wooden buildings, and of the terrible consequences of the failure of stands and other similar structures, the duties and responsibilities of borough engineers in connection with the administration of this section of the Building Act are of no minor character. But there will be no shrinking from responsibility nor evasion of duty, and, as the examination of these structures by district surveyors has given the public confidence in their stability, and has been regarded as a guarantee of their safety, the borough engineers of the metropolis will not allow that assurance to be weakened or destroyed, now that the erection of the structures has come under their supervision.

Much confusion and difficulty have arisen owing to the imperfect legislation connected with the transfer of the powers referred to, and from the first it was foreseen that in the working of Part VII. of the Building Act, under the incomplete provision which had been made therefor in the London Government Act, 1899, there would be uncertainty, friction and misunderstanding. In dealing with the subject, reliance seems to have been placed in sec. 29 for providing a remedy for any deficiencies and shortcomings in the Act, but this can scarcely be regarded as justification for the inefficient character of the legislation on the subject under consideration.

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The intricacies of the London Building Act, 1894, are so well known, that in attempting to express one's views on any part of it, it is necessary to state that they are put forward with a due consideration of the uncertainty of one's position and of the scope which exists for disagreement. It is hoped, therefore, that what is said will be received as impressions rather than regarded as dogmatic opinions. There is apparently nothing in the Building Act, or in the London Government Act, which would prevent the London County Council dealing with a wooden building or a wooden structure under secs. 82 and 83 of the first-mentioned Act (with the exception of "Coronation stands," which the King's Bench Divisional Court, in *Metropolitan Borough of Westminster* v. *London County Council*, decided must be dealt with by the borough councils under sec. 84, and not by the London County Council under sec. 83 of the Building Act. Apart from the structures, however, it seems that the London County Council may have jurisdiction, under secs. 82 and 83, in the same cases as the borough councils have under sec. 84, and that an application which has been refused by one authority may be submitted to and granted by the other.

There is no definition in the Building Act either of "building" or "structure," and unless a building is a structure a borough council could not issue a licence for the erection of a wooden building. In secs. 82 and 83 the words "building or structure" are used, and the omission of the word "building" from sec. 84 is remarkable. It may perhaps be urged that the borough councils have no jurisdiction in the case of wooden buildings, and that their powers relate only to wooden structures.

A licence having been obtained from a borough council, the builder or the person directing the work to be executed must give notice to the district surveyor and supply the information relating to the building or structure specified in sec. 145, sub-sec. *c*, of the Building Act; and the work is subject to the supervision of the district surveyor pursuant to secs. 138 and 146 of the Act. Doubts having arisen as to the duties of district surveyors respecting wooden structures under sec. 84, the Westminster City Council and the District Surveyors' Association obtained the following decision of the King's Bench Divisional Court on several questions:—

(1) "The powers, duties and liabilities of the district surveyors with respect to the supervision or inspection of

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wooden structures, falling under sec. 84 of the London Building Act, have not been transferred to the city council and its officers; but the district surveyors have no powers, duties or liabilities under the licences granted by the city council."

(2) "Wooden structures falling within the said sec. 84 are works of which the district surveyor should have notice under sec. 145 of the said Act in a proper case."

(3) "The right to receive the fees for such supervision and inspection, specified in paragraph 15 of the said special case, has not lapsed nor has it been transferred to the city council and its officers."

The position created by the latest attempt at legislation for the improvement of local government in London is obviously an awkward one for all concerned with wooden structures. The borough engineer advises his council on an application for a licence, which is granted by them subject to conditions which they impose; the erection is supervised by the borough engineer on behalf of the council, and the builder naturally regards him as the person whose directions he must follow, and whom he must satisfy. But the builder must give notice to the district surveyor, who knows nothing of the borough council's requirements, and has no copy of the plans or of the licence, and who, moreover, has neither powers, duties nor liabilities under such licence; he, perhaps, makes requirements of his own in addition, or contrary, to those of the council. In the police court, where the builder would be called upon to answer for his failure to comply with the conflicting requirements of the borough council and the district surveyor, the confusion would be complete, the former taking proceedings under paragraph *e* and the latter under paragraph *d* of sub-sec. 3, sec. 200, of the Building Act, 1894, and sec. 7 of the Amendment Act, 1898.

The remedy for the present unsatisfactory condition of this subject might be obtained by further legislation determining all the powers, duties and responsibilities of the London County Council and district surveyors with respect to wooden structures licensed by borough councils, or by transferring the administration of Part VII. of the Building Act to the borough councils, and determining the above-mentioned powers, etc., with respect thereto.

Through a defect in paragraph *d* and *e* of sub-sec. 3, sec. 200, of the Building Act, 1894, a conviction thereunder can only be

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obtained by taking proceedings under sec. 7, or secs. 6 and 7, as the case may be, of the London Building Act 1894 (Amendment) Act, 1898. A borough council may proceed under sec. 170 of the Building Act, 1894, for the demolition of a structure, where the conviction has been obtained by such council.

DISCUSSION.

The PRESIDENT: The remarks of Mr. Barber seem to indicate a tangle which will be a task for Municipal Engineers in the metropolis to unravel, and which I will not attempt to solve or propose to remedy, as there are present a number of gentlemen better acquainted with the intricacies of the Building Acts of the metropolitan area than I can be. In my own district the council cut the Gordian knot by appointing the district surveyor as well as the borough engineer, and that arrangement has, I can assure you, cleared away many difficulties.

Mr. W. WEAVER: Mr. Barber has placed very clearly before the meeting the difficulties of the metropolis with regard to wooden structures. What is to be the remedy is for the meeting to discuss. At the present time it seems, the only benefit—if it is a benefit—which has accrued to the Metropolis through the amending legislation of 1894 and 1898, is that people are paying twice over for the same thing. The practice in my district is for a person to pay a fee of 5*s.* when he deposits his plans and drawings, a further fee of 5*s.* for the licence, and then the district surveyor comes along and draws his fees afterwards. That is a state of things which ought not to be allowed to go on. My own view of the remedy is a somewhat more drastic one than that indicated by Mr. Barber in his paper, and it is that the entire work of building supervision in London should be placed on the same footing as in the large towns outside London. That is to say that the functions of the district surveyor and the borough surveyor should be amalgamated; and that the borough council of a district should have the supervision of the work of its district—that it should have not only the supervision of the water-closets of a building, but of the building of which the water-closet forms a part. I think that would lead to a very great simplification of the work of the metropolis, and also tend to elevate the dignity of the position of the borough surveyor.

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The convenience that would accrue to the public would be immense, as will be realised when we consider what a builder has to put up with when he starts work in London. We will presume he wants to develop a piece of land. First he desires to make roads; he goes to the town hall of the district, and is told he must prepare and submit duplicate plans to the county council. After a time his plans are passed and he makes his road. Then he wishes to construct sewers; duplicate plans and sections must be submitted to the local authority; then he has to give notice to the same authority as to commencement of foundations and submit plans of drainage; at the same time he has to give notice to the district surveyor to show that the buildings to be constructed on those foundations are correct. Then he goes on to build his house and drain it. Here, again, there is one staff to look after the erection of the building and another staff supervising the drainage. Then if the builder wants to vary the line of frontage he has to submit duplicate plans to the county council. The remedy for this circumlocution and duplication is that the work of the London boroughs should be assimilated to the work of the boroughs throughout the country; and I am pleased to say that my efforts in that direction are gradually having effect. I had to-day a letter from a leading member of the London County Council urging me to do what I could to press on the matter; and a circular has recently been sent out from the Paddington Borough Council to all the councils in London asking whether they are willing to appoint delegates to a conference at Paddington to consider the advisability of transferring the duties of district surveyors to the borough surveyors. The member who has written to me says he is sorry to say there is a good deal of apathy on the part of borough councils on the subject. I ascribe that to the fact that the members of the councils do not grasp the difficulties of the situation so well as their officers; and, therefore, do not take it up with any degree of warmth. I would urge surveyors to work in the direction of the reform advocated. I am convinced it is the right direction, and will be to their interest as well as the interest of the public. Failing the wholesale reform, the present clause and consequent confusion as to wooden structures must not be allowed to remain, for if the Act is not going to be transformed entirely, the part which deals with this point must be amended. I have already asked my Council for advice in the matter, and my report has

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been referred to the Law Committee. I want my responsibilities fixed, and I think it will be a good plan for the other metropolitan surveyors to do the same thing; because if there is a serious accident and some lives are lost, and you have to appear before a coroner's jury, you will find there is always a disposition to saddle the blame on some official if possible. It is just as well to know how you stand, so that you can do your duty without getting into trouble. I have pleasure in moving a vote of thanks to Mr. Barber for his paper.

Mr. W. NISBET BLAIR: We are indebted to Mr. Barber for opening this subject so clearly to us. I have experienced many of the difficulties which Mr. Barber has in the matter of these wooden buildings. One of the difficulties is to distinguish between that which may be approved by the district surveyor acting for the London County Council under sections 82 and 83 of the Building Act, from that which must be approved or erected under licence by the borough council under section 84. It was not long before I found a difficulty in distinguishing between the two, and therefore wrote to the Superintendent Architect of the County Council asking him if he would advise, whether in cases given, this building or that ought to be approved by the district surveyor or be licensed by the borough council. The reply to that letter did not elucidate the matter, but rather made the confusion worse confounded, while leaving us entirely to our own judgment. Then the position of the district surveyor as determined by the High Court, opens up a further possibility of conflict with the position of the borough surveyor. So far, I have avoided anything like ill-natured controversy with the district surveyors, though we have had discussion without much result. The proposals we have heard from Mr. Weaver were unanimously approved at a Conference of London Municipal Surveyors and Members of their Boards some four or five years ago, and were represented to the London County Council, and had the effect in the London Building Act Amendment Act of transferring to the borough councils, not the powers they asked for of the control of all buildings in their districts, but only the supervision and licensing of these wooden buildings, the regulation of sky-signs, and a third power of equal dignity, the regulation of the stacking of timber on vacant land. Those are the three powers and duties transferred to the borough councils in answer to their request that they should be placed in charge of all

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building operations in their district, so that any builder in executing work might be regulated by one authority and one officer. Having so completely failed to get what we wanted, then, my Committee thought when we received the circular from Paddington ten days ago, that it was utterly futile to re-open the matter, and decided that the Paddington Council should be informed; we did not think it worth while to re-open the subject again. Therefore I think that method of remodelling legislation cannot be entertained as probable at present. Now, what other course is there available? There is one that was suggested to me by a district surveyor. We can quite understand that they do not wish to lose their control of these things because every matter of advice given or supervision undertaken by a district surveyor means fees. District surveyors have to live by their fees; they are not like borough surveyors who are salaried officers. We are entitled to charge a fee for the licence, but it is only supposed to be a nominal one. In our case we charge a fee of 5*s.*, but not the additional 5*s.* Mr. Weaver has spoken of. That is received by the borough council's exchequer and not by the borough council's officer. The district surveyor then comes along, agrees that the thing is all right, and sends in his account for fees, which he will get because he can sue for them. One of the district surveyors has suggested to me that without involving the borough councils in any fiduciary arrangement with the district surveyor it should, in its licences, require the building licensed to be erected in accordance with the plans approved and to be carried out to the satisfaction of the district surveyor, he being named in the licence as the officer to whom satisfaction must be given in the erection of the building. I agree that we should be careful as to how far we undertake a personal liability in approving that which may have elements of very considerable risk. Therefore, I think that solution of the difficulty is in some respects not at all a bad one. It is, practically, transferring back to the district surveyor that power which was given to us by the Building Act Amendment Act of 1898. The duties then transferred were insignificant, but they were onerous duties, which we have not appreciated and did not want. There are many questions involved. I began by referring to the difficulty of distinguishing between buildings referred to in sections 82 and 83 and those under 84. A wooden frame building covered with corrugated iron, with its sides of corru-

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gated iron, and with one of its sides against a brick wall, would not be a building we ought to license; it would be a building to be approved by the district surveyor. But take away the corrugated iron sides, and it becomes a building we ought to license. Now what I understand has actually happened is this. In a rapidly extending district in London—I will not name the district—where many people desired to add on a shed at the end of a house, but which by the provision of a door, becomes a room of the house, and gives valuable additional space, the builders have endeavoured to get the consent of the London County Council to such additions. The London County Council have disapproved of these buildings. What the builders have done is to make new tracings of the same thing, omitting the corrugated iron on the sides, sent it to the borough council as a wooden building, and got the plan passed. Thus a structure has ultimately been erected which was worse than that disapproved by the district surveyor. Then there is the question whether these wooden buildings may be erected at a less distance from the centre of the street than the Act prescribes. The feeling of the County Council as to buildings of a temporary character—a rabbit-hutch, or a hen-house, or a bicycle-shed in a garden, for instance—is that such erections must not be within less distance than the prescribed distance from the centre of a street, and must not be in advance of the general line of building. That makes one wonder what this section was really devised for, and my own impression is that the first thing which occurred to the draughtsman who prepared this section were matters such as stands to view processions, and such-like temporary structures. Now these, in ninety-nine cases out of a hundred, are erected in advance of the general line of buildings, and therefore could not be made to comply with the regulations of the Council. Therefore the Council, through its building committee, has given an instruction that where these structures are of a temporary character, and required for only a few days, no objection is to be taken that they are in advance of the general line of building.

Mr. NORMAN SCORGIE: I fancy Mr. Barber has put the responsibility in reference to these structures at a rather high altitude. Personally, I have not found the difficulties Mr. Barber has suggested would come into the province of a borough surveyor perhaps it is owing to the very genial gentleman I

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have to deal with as district surveyor. Any matter which comes to the knowledge of the district surveyor which he thinks I ought to deal with he hands over to me, and anything which I think comes within sections 82 and 83 I acquaint him with. A reference has been made to structures in advance of the general line of buildings. Whether such structures are temporary or permanent, that I think is a matter for the County Council only. I recently had a curious case to deal with. A house, with a long forecourt, became occupied by a photographer, who erected in this forecourt a stand on four legs for the display of photographs. Remembering the case of Brown *v.* Leicester Corporation, I mentioned the matter to the London County Council, who granted him a licence for the structure for twelve months, renewed it for a further twelve months, but declined again to do so. The photographer, instead of removing it, cut off the posts at the ground level, and put four little wheels beneath the structure, and, as it then became a temporary structure, the County Council said they could not deal with it, and referred it to the Borough Council, who said, "if you won't deal with it we won't deprive the man of his livelihood," and so the structure remains to the present day. The difficulty is to know where one responsibility begins and the other ends. As far as my district is concerned, I think the district surveyors have handed it over to me. The only structures we have had to deal with have been motor-car sheds or erections to cover bicycles. The Council will not allow any wooden building which is to be tacked on to the end of a house, but will allow such structures at the bottom of the garden. We have granted about five licences for which, like Westminster, we charged a fee of 5*s.* when the plans were deposited, and a further 5*s.* when permission was given, and we only grant the licence for a limited period, possibly in order to get another 5*s.* when application is made for renewal. As to the transference of the powers from the district surveyor to the borough engineer, I cordially agree with Mr. Weaver that that ought to be done, but if done, I think the borough engineers must have a separate and distinct appointment independent of their councils. As you know, there are certain influences always at work to get the Council to sanction buildings which are not strictly in accordance with the requirements of the Building Act.

Mr. E. B. NEWTON: In Paddington the procedure we follow

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is very much that which has been described, except that in no manner do we recognise the office or authority of the district surveyor. We consider that, following the judgment which was given in the King's Bench—on the case stated—since our licences refer solely to the borough surveyor, to that extent only is a builder under the authority of any officer—that is to say, we act on the assumption that unless the licence refers to the district surveyor he has no authority to inspect a wooden structure. Of course, that view is not shared by the district surveyors, and we have many cases of hardship arising out of that conflict of opinion. There is no doubt the dual jurisdiction operates unfairly to builders. Recently 80 huts were licensed as coal sheds for which we should now charge a licensing fee of 5s. and a further fee for inspection. After we had licensed the huts the district surveyor stepped in and demanded further fees at the rate of 15s. for each wooden structure, and these fees altogether amounted to a considerable proportion of the whole cost of the huts. The builder refused to pay the second lot of fees and the district surveyor took out a summons, whereupon the builder paid the fees rather than incur any further legal expense.

Mr. O. E. WINTER: It seems to me that the transference of the powers of the London County Council to the borough councils as regards wooden structures only was a most unnecessary alteration of the Building Act of 1894. Mr. Weaver has very fully described the difficulties in which a builder finds himself, if he is not familiar with the London Building Act; and a country builder who happens to carry out work in London is at a much further disadvantage. The Public Health Department of my Council had a case in court a short time ago, because notice was not given of certain additions to the drainage work in connection with the extension of a building; the builder was under the impression that the Building Acts were similar in London to the country by which a plan and notice to the local authority covered everything: consequently, he got into trouble with reference to the drainage work, and was summoned and fined. It appears to me that the only rational procedure is that all building work ought to be supervised entirely by the local authority or by the County Council. To single out these few minor matters such as wooden structures for the supervision of the local authority seems to me absurd. I have had no

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difficulties in respect to wooden structures in my district. But the majority of cases have been such small structures as pigeon-houses and rabbit-hutches. It does seem to me that the only reasonable course to adopt is for the London borough councils to persevere until the Building Act is administered by them. The building bye-laws could be settled by the central authority, but so far as the administration is concerned, the practice should conform with that in the provinces.

Mr. ARTHUR HARRISON: I am one of those engineers who have had a good deal of experience of this section of the Building Act. During the Coronation period, stands were erected in my district to accommodate over 70,000 persons, one stand alone accommodating 4000. One of the district surveyors suggested we should approve the plans, and he should supervise the structure; this seemed a reasonable solution at first. But would the district surveyor supervise a structure which is in accordance with drawings approved and to our requirements, or would he have alterations made without our consent, and in the event of an accident who would be responsible? Many of the plans submitted of stands at the Coronation were of a very rough character, and I should say that out of every hundred plans submitted to me, I had to make alterations in ninety-five of them. Some of the plans were submitted by people who had not the least idea of utilising timber, and some of them seemed to have forgotten how to put a timber structure together. The whole thing was disagreeable to work owing to the indefinite position of the borough engineer and the district surveyor. In our district we had a deposit of 5*s.* when the plans were submitted and another 5*s.* when the plans were approved, and a further charge according to the accommodation of the stand. Altogether we received about 600*l.* in fees; we, of course, had some expenses. Then the district surveyor also demanded his fees from the builders. In some cases, the district surveyor wanted alterations made. I gave instructions that in no case were alterations to be made without my approval, and that arrangement was carried out. One of our structures was condemned by the district surveyor, but I did not have it taken down; I asked him to have it taken down if it was so dangerous, but it stood through the whole time it was required. In another case he required certain alterations which I would not have carried out. In another case I might point out, where I approved the stand the district

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surveyor went round himself and also approved it without any alteration, and then his assistant came round and condemned the lot. When the fees were to be collected, in every case that the district surveyor took before the magistrates he was successful, but it was suggested that modified fees should be charged. He also took the Southwark Council before the magistrates for fees, but it was arranged this case should stand over—and it has been standing over ever since. The Council were anxious about the unfortunate position that I was put in, and were anxious to have the jurisdiction of the district surveyor settled, and were prepared to take the case to the High Court. Of course, if the district surveyor has a duty under this section, I think he ought to be paid for his work, but it is absurd to have two authorities doing the same work. I do not know whether the district surveyor is going to re-open the question, but I do not think he is. Since then we have had a number of applications for temporary wooden structures, and every one of those applications I have advised the Council to disapprove, as I consider the erection of wooden huts in a district like ours should not be encouraged. But if we had the full power under Part 7 of the Building Act transferred to the Borough Councils, I believe we could do very good work; and many of the inferior wooden structures which have been erected in some districts in London would not have been passed. If Part 7 of the Building Act were taken out of the control of the London County Council and the district surveyor, we ought to get a great improvement in regard to temporary buildings, because the borough councils are able, through the number of their officers about the district, to keep a much better control over these structures than the London County Council and district surveyors.

Mr. S. G. GAMBLE: As an old surveyor I know the difficulties of defining what is and what is not a temporary structure. From the fire brigade point of view, these structures become in the course of a few years filled with all kinds of material which people turn out of their houses, and as a result very dangerous.

The PRESIDENT: It seems to me that filthy lucre is at the bottom of this trouble, like many others, and if the metropolitan authorities had the pluck to do what some of the large towns in the provinces have done—abolish building fees altogether and pay their officers properly—it would be very much better. I should be sorry to think that any portion of my income was

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derived from fees paid by a builder. My Council discontinued that practice of their own free will some years ago, and the result has been very good. We should be very sorry to go back to the days when builders had to pay fees for their plans or buildings to be inspected. A borough surveyor or a district surveyor is in a much more independent position if his income is paid directly by his corporation, and if that corporation do not themselves receive the fees, because if builders pay fees you cannot persuade them that the amount is not going into the pocket of the surveyor. I think the metropolis has something to learn from the large provincial towns in this respect.

Mr. J. PATTEN BARBER, in reply, said: I am much obliged for the vote of thanks you have given me for the few remarks I made. Several speakers have brought in the words "temporary building." Now section 84 of the London Building Act, 1894, has nothing to say about *temporary* building or structure; it only refers to wooden structures, and does not characterise them whether permanent or temporary. Temporary buildings are referred to in section 83. We have only been dealing to-night with section 84.

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EASTERN DISTRICT MEETING.

June 13, 1903.

Held in the Town Hall, Sudbury, Suffolk.

T. H. YABBICOM, M. INST. C.E. PRESIDENT, *in the Chair.*

THE Mayor (Councillor H. Baker) received and welcomed the Members of the Association.

The President tendered to the Mayor sincere thanks for the welcome which he had given to the Association.

The Minutes of the last Eastern District Meeting at King's Lynn were read, confirmed and signed.

A vote of condolence was passed with the family of the late Mr. G. H. Sasse, Borough and Water Engineer of Chelmsford, whose death had occurred on the previous Tuesday.

SIX YEARS' MUNICIPAL WORK AT SUDBURY.

BY T. W. A. HAYWARD, A.M. INST. C.E., ETC.,
BOROUGH ENGINEER AND SURVEYOR, SUDBURY.

INTRODUCTION.

WHEN the Author was asked if he could not arrange for an Eastern District Meeting of the Association of Municipal and County Engineers, he expressed his views that Sudbury was not of sufficient size or importance to warrant a meeting being held there, but he was assured that it was the wish of the Association to have meetings in the smaller as well as the larger towns; and it is hoped that the public works, even though they are only on

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a small scale, may be of some interest to the Members of the Association. The Author looks upon it as a great compliment paid both to the Corporation and himself, that Members should express a desire to come and see what is being done in this ancient borough.

Historical.

The early history of the borough of Sudbury is veiled in the mists of antiquity, and historical records are silent as to this town prior to the eighth century, when it was already a place of some importance. But considering its favourable situation on a gravelly eminence in the fertile valley of the Stour, that it commands means of communication both by road and river, in all probability it was occupied, in the days of the Romans, by a settlement of the Iceni, the powerful British tribe in whose territory it lay. For close by the adjoining parish of Long Melford many Romano-British relics, in the form of sepulchral urns and coins, have been discovered.

The name, however, is Saxon, and tells its own story: "Sudbury" (Suth-Burh)—the fortified town in the South (of East Anglia)—and this was its name when it first appears in history (in the Saxon Chronicle) under the year 797 A.D., when we are informed that Ælfhun, Bishop of Suffolk, died at Sudbury, whence his body was carried for burial to Dunwich, where the episcopal see was then fixed.

In the reign of Æthelred II. (979–1016) Sudbury possessed a royal mint, and many coins struck here by the moneyers Ælfnoth, Ælfric, Brightlaf, and Godwine, marked SUDBY on the reverse side, have been discovered. Coins continued to be minted here for Edward the Confessor (1042–1066) by Folcwine, the moneyer; and after the Norman Conquest, for William the Conqueror, William Rufus, and Henry I., by Wulfric, the moneyer; they are marked SUTHBY on the reverse.

A piece of land in King Street, called in its title-deeds "the Mint" is said to be the site of the old Saxon Mint, and is now known as "Belle Vue."

Sudbury is mentioned in several places in the Domesday Book.

It is supposed to have been in early time the chief town in Suffolk, and to have received its name in contradistinction to Norwich in Norfolk.

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By the Conqueror it was given to Richard de Clare, and from the Earls of that name it obtained important privileges.

It is a Borough by prescription, but obtained its first charter from Mary in 1554. It obtained others from Cromwell and James II., and its Governing Charter is that of Charles II.

The office of Mayor of the Borough of Sudbury is a very ancient one, having its origin in the dim and distant past, when "the memory of man runneth not to the contrary." The first mention of the Mayor of Sudbury that has been discovered occurs in the Patent Rolls for the year 1331, when one Robert Darry, Mayor of Sudbury, with others, is ordered to aid in arresting certain persons indicted for felonies, who were still at large in Suffolk. The ancient Charters are in good preservation, as are also the Seal, Maces and Loving-Cup: these are much prized by the Corporation, and by the free and independent burgesses of the Borough.

There are many interesting and quaint customs connected with its history, but as these form no part of engineering work space will not allow them to be mentioned here: it may, however, be of interest perhaps to some Members who love antiquity, to know that the skull of one Simon de Sudbury, sometime Archbishop of Canterbury, and who was murdered in the time of Wat Tyler's rebellion in the year A.D. 1382, is preserved in a glass case in the Church of St. Gregory, and can be seen there.

District.

Sudbury lies in the valley of the river Stour, which here separates Suffolk from Essex, part of the borough being in Suffolk and part in Essex. The geological formation is chalk, covered either with brick earth, drift sands and gravels, or boulder clay. Its distance from London by the Great Eastern Railway is sixty miles. It can be approached by water from the North Sea by means of the river Stour, which is navigable as far as Sudbury.

Industries.

The town owed its early importance to the introduction of woollen manufactures by the Flemings at the instance of Edward III. The principal industries at the present time are silk-weaving, mat-weaving and corset-making. Sudbury is also a market town of some importance.

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Statistics.

The population in 1881 was 6592; in 1891, 7059; in 1901, 7109. The rateable value is 21,000*l.*; the area, 2093 acres. The average birth rate for the past ten years is 23 per 1000, and the average death rate, 18 per 1000.

It will be noticed that the rateable value is very low, and this is where any expenditure is most keenly felt, a 1*d.* rate only producing approximately 80*l.*

Public Loans.

The loans for public purposes which have been raised by the Corporation are as follows: (1) Under a private Act of Parliament for street improvement purposes generally, 10,000*l.* This was taken up in the year 1840 and is still owing, none of the principal sum being repaid as is now usual.

Loans under sanction from the Local Government Board, are:—

—	Amount Borrowed.	Amount Paid off.	Amount Still Owing.
	£	£	£
2. For Bathing Place	400	213	187
3. For Technical Institute	650	39	611
4. For Works of Water Supply ..	8,450	7,500	950
5. For Street Improvements	3,475	320	3,155
6. For Private Street Works	3,275	417	2,858
7. For Sewerage and Sewage Disposal	24,442	273	24,169
8 For Refuse Destructor	1,810	..	1,810

All these, with the exception of the Private Street Works Loan (which was obtained from an Insurance Society at 3¾ per cent.) were obtained from the Public Works Loan Commissioners at 3½ per cent.

Water Supply.

The water supply of this borough has a somewhat unique history. In the year 1870, the Town Council were served with an order from the Local Government Act Office, to provide a

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proper supply of water within six weeks from the date of the order, and that "if the duty of providing a proper water supply for the borough be not set about by the time limit set forth in the order, the Secretary of State would appoint a person to perform the same." The Council refused to comply with this order, and Her Majesty's Secretary of State (Mr. H. A. Bruce) appointed Mr. Thomas Hinnell, M. Inst. C.E., of Westminster, to carry out the work on his behalf, and this was done at a cost of 7500*l.* Very little was done in the way of extending or improving the works for upwards of thirty years. The water is derived from a boring in the chalk at a depth of 375 feet, a well being sunk to a depth of 75 feet from the surface, a 12-inch boring 100 feet below that, and a further 9-inch boring 200 feet in depth. Originally there was an abundant supply of water, but this has fallen off considerably since the earthquake of 1884, which by some means reduced the supply by about one-half.

For many years prior to the Author's appointment, the water question had been a cause of considerable anxiety to the Corporation. They had obtained expert advice, had deepened the well, extended the boring, and had done various other things to try and increase the supply, but without any satisfactory results. On the Author's appointment he was informed that the water supply question was one which would demand his first and most careful attention. Gaugings were taken as to the inflow of water into the well through the bore-tube, and it was found that the supply at that time was sufficient for the reasonable needs of the borough. Attention was next given to the distribution, when it was found that an average of twenty-five gallons per head was being sent from the storage reservoir into the town. This being high, some investigations were made, and on the Author's advice, the Corporation purchased some Deacon waste-detecting meters, when several large leakages were detected which had probably been going on in the mains for a great number of years. Copies of the first diagram taken from the meter on the trunk distributing main showing the consumption on October 7, 1897, before the leakages were stopped, and one on November 24, 1897, when most of the leakages had been repaired, will explain themselves. It will be noticed that considerably more than half the water which was then being sent from the storage reservoir was running to waste. When the leakages were stopped it was found

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that a continuous supply of water could be given, whereas previously it had been shut down for seven hours every day, and it need scarcely be added this constant supply was appreciated by the inhabitants.

The diameter of the well is 7 feet 6 inches, and the water will rise to a height of 14 feet above the bottom. The storage capacity therefore is only about 4000 gallons. The capacity of the larger pump is such that, when driven at its normal rate, it will empty the well in ten minutes, the inflow not being sufficient to maintain the level. The Author has therefore prepared a scheme which, by increasing the storage capacity at the bottom of the well, will permit the pump being driven at a normal rate continuously throughout the day, and it is expected that during the night, the inflow from the bore tube will raise the water to its normal level. This scheme has been accepted by the Town Council, and approved by the Local Government Board, and the work will probably be carried out in the near future. During the last six years some four miles of new mains have been laid, additional services put in, the service reservoir has been cleansed and repaired, the whole of the plant and machinery have been thoroughly overhauled, a new boiler with patent furnace installed, whereby breeze can be burned in lieu of coal, one new pump put in, the old pumps lowered nearer their work, the waterworks buildings extended, and, generally the entire undertaking put into thorough going order—the whole of which has been paid for out of revenue. All the water for fire brigade purposes, street watering, sewer flushing, and other municipal purposes is supplied free of charge. Notwithstanding this, during the last three years the undertaking has shown a net profit of nearly 600*l.* per annum.

A new set of rules, regulations and charges has been prepared and adopted by the Council.

During the carrying out of the sewage scheme, springs of water were tapped near the sewage pumping station, samples of which were submitted to the county analyst for analysis, which, proving satisfactory, the Author advised the Council to put an iron cylinder down the contractor's sump so as to be able to utilise this supply of water at some future time should it be required.

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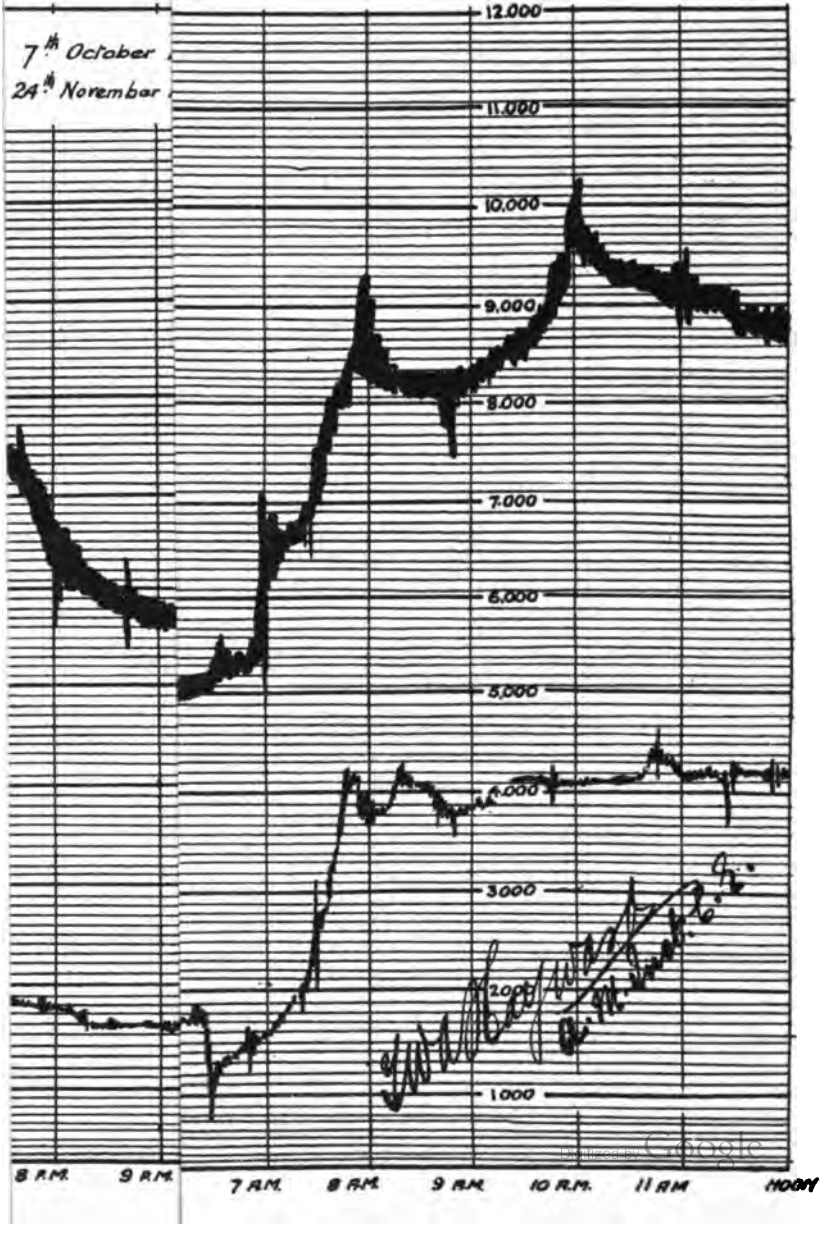

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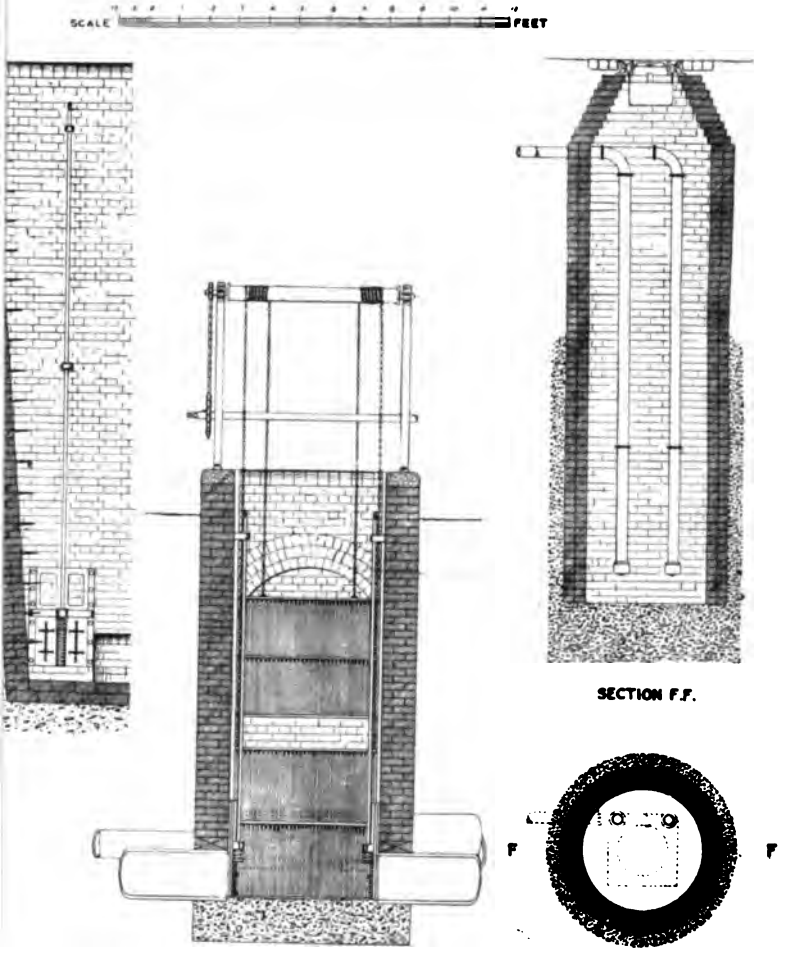
TION OF SUDBURY. WATERWORKS DEPARTMENT.

S OF SCREENING CHAMBER.

DETAILS OF WELL.



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Public Lighting.

The streets are mostly lighted by gas, there being about 200 public lamps, which are lighted at a cost of approximately 2*l.* per annum for 1200 hours' burning. There are also twelve oil lamps of 50 candle-power, which cost 35*s.* each per annum. The gasworks, which are in the hands of a private company, were erected in the year 1836 at a cost of 5000*l.*, and have since been enlarged and improved. The charge for gas to private consumers is 4*s.* 7*d.* per 1000 cubic feet for lighting or cooking purposes, 4*s.* for gas engines, and 3*s.* 9*d.* to the Corporation for street lighting.

The Corporation obtained a Provisional Order for electric lighting some three years ago, and intended to carry out a scheme of electric lighting themselves, but owing to the small rateable value of the town it was not sanctioned by the Local Government Board. The Corporation are now negotiating with one or two firms for the leasing of the order until they are in a position to take it up themselves. Sudbury being a compact town for electric lighting purposes, it was felt that a moderate scheme would be self-supporting, and it was with great regret that the Council had to abandon it.

Roads.

There are 14 miles of roads in the borough, and although several miles are what in other counties would be considered "main roads," in West Suffolk, the County Council do not recognise any main roads, and do not pay any contribution towards the upkeep, so that the cost of maintenance of the whole of the roads has to be borne by the ratepayers of the borough. Practically all the roads are macadamised, and mostly made of local flint stone. This is a most unsuitable material for roads, especially in the town, owing to the great trouble experienced with the dust in the summer time, or in dry windy weather. The Corporation, however, are beginning to realise that though the first cost of a harder and better stone is greater than local stone, advantages of a longer life and the saving in scavenging will repay the greater initial outlay, and the Author hopes that before long local stone will be superseded, at least in the main thoroughfares, by granite. The cost of the local

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flint stone is 7*s.* 6*d.* per cubic yard delivered on to the roads, and Leicestershire granite about 13*s.* per ton delivered at the station. The Author asks for the indulgence of the Members in the matter of roads to-day, as they have all recently been cut up for the laying of the sewers, and have not yet been made up.

In making up the streets after the sewerage operations, the Author advised the Council to allow him to put in channels 12 inches wide with 3-inch Staffordshire bricks. Previous to this there were no channels to the sides of the road, other than those formed by the ordinary macadam formation.

Footpaths.

The footpaths in the principal streets are paved with York stone flags with granite kerbs. These pavements were laid some years ago, and where they are much worn and need considerable repairs, the Author has recommended the use of Victoria stone slabs or granolithic concrete laid *in situ*, and this has been carried out to the extent of about 400 yards. The cost works out at from 3*s.* to 4*s.* per superficial yard. In some of the side streets concrete pavements, composed of five parts pit shingle to one part Portland cement, have been laid at a cost of 2*s.* 3*d.* per superficial yard. During the last two years about 10,000 lineal yards of footpaths, varying in width from 3 to 12 feet, in the outlying parts of the borough, have been laid with tar paving 2½ inches thick, 1¾ inch of bottoming and ¾ inch of topping. Some of these have been laid with limestone bottomings and toppings, working out at a cost of about 2*s.* per superficial yard; others, with 2 inches tarred flints and 1 inch of limestone toppings, at about 1*s.* 6*d.* per superficial yard. The kerbing used for these paths is formed with Staffordshire blue brick, 9, 12 and 16 inches deep, and 3 to 4 inches wide on top, according to requirements.

	in.	in.		s.	d.		
The	9	by 3	kerbs cost	1	9	per yard run fixed.	
„	12	„ 3	„	2	4	„	„
„	16	„ 3	„	3	6	„	„
„	12	„ 4	„	3	10	„	„
„	16	„ 4	„	4	8	„	„

The channels in most cases have been put in with blue

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bricks on concrete at a cost of 1*s.* 7*d.* for channels 12 inches wide, and 2*s.* 1*d.* for channels 15 inches wide. Some of this work has been done out of revenue, but the larger portion out of loan.

Private Street Works.

A large number of private streets have been made up, and are now being taken over by the Corporation. The Private Street Works Act, 1892, was adopted by the Council, who have borne about half the cost of making up the streets, and in addition thereto have put in sewers and surface water drains. The instructions the Author received from the Corporation were to prepare a specification, and have the streets made up at as low a first cost as possible. The specification adopted for a 40-feet street was generally as follows: The roadway to be levelled and all inequalities filled up with hard material, a layer of brick rubbish or other hard core about 3 inches thick, filled in with binding, and well rolled with a 10-ton roller. On the top of this a layer of chalk, and finally a layer, 4 inches thick, of local flint stone, thoroughly well rolled and consolidated. Blue brick kerbs 3 inches thick, 9 or 12 inches deep. Channels formed with blue bricks 15 inches wide, laid on concrete and bedded in cement. Footpaths filled up to within 3 inches of the finished level with clean hard suitable material and well rolled. Then 2 inches of tarred flints, and 1 inch tarred limestone toppings. The cost of a street made up thus worked out at about 8*s.* 6*d.* per foot lineal. The sewers and connections were laid at the expense of the Corporation. All the work in connection with these private streets was carried out by administration, and proved most successful, as the work was completed at nearly 50 per cent. less than the lowest tender received for the job.

Tree Planting.

Trees have been planted in some of the roads, and it is hoped they will in the near future be extended to other roads. The trees are placed about 25 yards apart. About a cubic yard of soil was filled in with each tree as it was planted, and the trees are stayed with a stiff stake. The cost of the trees, planting, and the extra kerb around them in the footpath, is about 13*s.* each.

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In addition to the trees in the streets, two dozen oaks were planted on the Croft—a large open space to the north of the Town Hall—last year in commemoration of the Coronation of King Edward VII. The avenue formed by these trees is named King Edward's avenue.

Stables and Depot.

The depot has been enlarged by the Author, and comprises stabling, hay and corn stores, sheds for the housing of all carts, water vans, and other vehicles, steam-roller, fire-engine, and all the other Corporation utensils. The yard is used as a depot for various materials.

Public Bathing Place.

In the year 1894, a public bathing place was opened up on the river Stour, on the outskirts of the town. The river was dredged and a large area of water fenced in; dressing-boxes were erected, a promenade constructed, and open air bathing facilities afforded, for the modest sum of 500*l.*

The Author has this year made some improvements, and the place is largely patronised by the public, as may be gathered from the fact that it is nearly self-supporting. The charge to bathers is one penny.

Isolation Hospital.

There is an isolation hospital, but fortunately, owing to the very few cases of infectious diseases in the Borough, it is in very little request. During the smallpox scare of last year it was suggested to build a larger and more modern isolation hospital for the combined districts of the Borough of Sudbury, Melford Rural District Council, Glemsford Urban District Council, and Belchamp Rural District Council; but beyond the selection of a site nothing has yet been done.

Town Hall.

The Town Hall was built in the year 1828. It is used for Corporation Committees and Councils, Police Court, Assembly Room, County Court, Quarter Sessions, and the Borough Surveyor's Offices are located here.

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Collection and Disposal of House Refuse. Refuse Destructor.

Until within the past two or three years, the collection and disposal of house refuse has been most unsatisfactory. The refuse was allowed to accumulate in the back yards of cottages, and in nearly all cases fixed ash pits were provided, holding one, two, three or more cartloads of refuse. When these were full, they at times became very offensive and were a very serious menace to public health. As a first step in the way of reform, the Council undertook the collection of house refuse upon receiving a notification from owners that their ash-pit required emptying, but since the Author has held office, he has encouraged the use of movable ash bins, and where these have been adopted a systematic weekly collection is in vogue, and it is the intention of the Health Committee to extend this system.

The refuse up to the present time has been deposited at a refuse tip on the outskirts of the town, and has been a continual source of complaint.

By combining a refuse destructor works with the sewage pumping station, the combustion of the solid refuse waste not only provides all the steam power necessary for pumping the daily volume of sewage, but in addition to this, the residuum in the form of vitreous clinker filling material is provided for the bacteria beds at the disposal works.

Perhaps nothing is more interesting in modern sanitation than the effective way in which one class of civic waste—the refuse—may be utilised to economically treat another class of civic waste—the sewage. In such a combination not only is practical efficiency attained, but in addition to this we reach a high utilitarian and economic standard in the absence of a fuel bill for power production, the combustion of the refuse readily providing us with all the power required.

The destructor is of Meldrum's patent regenerative front feed type, and consists of two 2-grate units, each unit being provided with a Cornish boiler 15 feet by 5 feet for a working pressure of 125 lb. (by Davey Paxman and Co., of Colchester).

A regenerator for heating the air for combustion is included with each unit, which fulfils the twofold object of (1) supplying air for combustion heated up to a temperature of over 300° F.;

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by means of the waste gases, and (2) in securing silent working of the forced draught blowers.

The normal daily duty of the destructor will be to incinerate about five tons of refuse, but its capacity is such that as much as 18 cwt. per hour can be destroyed in one 2-grate unit. This provides not only for the future growth of the town, but also gives that useful elasticity which is desirable to allow the rate of combustion to be materially increased, as may be necessary for meeting the extra pumping requirements whenever an abnormal flow of sewage or storm-water may be experienced.

The destructor, although small by comparison with those of large towns, is yet complete in every detail.

The installation is an object-lesson, showing how useful for purposes of power production is such a small quantity as five tons of refuse per diem. As far as the Author is aware, there is not another town of the same size where a refuse destructor provides power for pumping sewage.

Sewerage and Sewage Disposal.

The most important works on which the Author has been engaged since his appointment in Sudbury, are the main drainage and sewage disposal works, which are now approaching completion.

In consequence of numerous complaints having been made to the Local Government Board with regard to the nuisance arising from watercourses into which crude sewage was discharged, and because of the intolerable nuisance created by the collection of the excrement pails, of which there were over 500 in use in the borough, many of these having to be carried when full through the living rooms of the cottages in order to be emptied, and also because of perhaps the greatest nuisance of all, caused by the emptying of the large foul privy middens in the centre of the town, the Author was directed shortly after his appointment to investigate the matter, and report as to the most economical way of remedying these nuisances. The instructions he received from the Committee were to the effect that in propounding any scheme the question of cost should be of primary importance. It was at first decided to lay new sewers in the main streets only, leaving out the low-lying, and properties otherwise difficult to drain. This scheme was how-

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ever incomplete, and when it was reported upon by Mr. J. T. Eayrs, M. Inst. C.E. (whom the Council consulted), this cheese-paring policy was abandoned. Mr. Eayrs, however, approved the general design of the scheme so far as it went, and after receiving his report, the Committee gave the Author directions to prepare a complete scheme as recommended. Sewers were to be laid in all the streets, and also through private lands and premises where necessary, so as to take the sewers as close as possible to the backs of premises which had to be drained, in order to minimise the expense of private connections. The Council further decided to put in connections to the boundaries of all properties, free of cost to the owners. This, it will be readily understood, enormously increased the cost of the scheme.

In addition to this, however, the Council decided to lay the sewers in some private streets that were being laid out, and also to thoroughly overhaul the existing brick sewers which were put in about sixty years ago, and to renovate and use these wherever practicable for carrying off storm-water. Where these old sewers were found to be in such a dilapidated condition as to be beyond repair, the Author recommended the construction of a new sewer for this purpose. Such is the general outline of the scheme.

System of Sewerage.

The Author deemed it advisable to adopt what is known as the partial separate system, and lay two sets of sewers throughout, one being for sewage, and the other for rainwater from streets, front roofs and open spaces. It was found that several miles of the old sewers could be utilised for carrying off storm and surface water, so that the total length of new sewers required for this purpose was about four miles, whereas the total length of new foul water sewers and connections is about twenty miles. The new storm-water sewers vary in diameter from thirty inches to six inches, and the foul water sewers from eighteen inches to six inches.

The outfall was selected at a point S.W. of the town, and from this two intercepting sewers were laid, one running from S.W. to N. and the other from S.W. to E. These two main intercepting sewers and also the main sewer in the district of Ballington (which part of the borough is in Essex) were laid in

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waterlogged ground, the subsoil being gravel and sand, the water rising to within about 3 feet of the surface. Under these circumstances it was deemed advisable to use iron pipes in the worst places; in less treacherous ground, Hassall's patent double lined jointed pipes, and Ames Crosta patent double seal jointed pipes were used, and have given entire satisfaction. All the sewers were tested to a six feet head of water at the highest end, no line of sewer being passed until it had sustained this test, and the water was kept in the pipes until the trench was partially filled in, so that no displacement should occur and pass unnoticed during the ramming of the soil.

The sewers generally are laid at good gradients, and in nearly all cases have self-cleansing velocities. Flushing man-holes are provided at the dead ends of all sewers, and where a grade is rather flat, automatic flushing tanks are provided. Where new storm-water sewers were required, they were laid in the same trench as the foul water sewer, but at different levels on benchings.

The Great Eastern main line was crossed once, and goods sidings six times. At one place, where the siding passed through a tunnel under the public highway, it was found necessary to carry the sewer beneath the line by using a specially designed iron inverted syphon. This syphon, which is about 20 yards long and 5 inches diameter, connected a 7-inch sewer laid at a gradient of 1 in 200 to a 9-inch sewer laid at a gradient of 1 in 250. At the end of the 7-inch sewer an automatic flushing tank of 1000 gallons capacity is provided.

Nothing further calls for particular comment as regards the construction of the sewers. The drawings exhibited on the walls will explain the general features of the scheme.

Collecting Tanks.

The collecting tanks were constructed in waterlogged and unstable ground, and great difficulty was experienced owing to the enormous quantity of water met with. The wells in the district for miles around were drained, and during a period of six months a quantity of not less than 60,000 gallons of water per hour was raised from the contractor's sump. The walls and floor of the collecting tanks are constructed of concrete, com-

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posed of one part of Portland cement, four of fine shingle and one of sand. The walls are 6 feet thick at the bottom and 3 feet at the top. The floor, which is 4 feet thick, is lined with 9 inches of blue brickwork set in cement mortar, and is constructed in the form of an inverted arch. A layer of expanded metal is embedded in the centre of the concrete, and a collar joint 1 inch thick of neat Portland cement is formed between the concrete and brick lining.

The outside walls are also lined with 9 inches of blue brickwork, while the partition walls, which are 3 feet thick at the bottom battering to 2 feet at the top, are built entirely with blue brickwork, the whole set in cement mortar.

It was anticipated that some difficulty would be experienced in making the tanks watertight; but at the present time they are absolutely so. The sewage, on reaching the collecting tanks, will pass through a screening chamber, where a specially designed screen is fixed, and the solids taken from this screen will be burned in the refuse-destructor. The storage capacity of the tanks is about 50,000 gallons, or more than the average estimated dry-weather night flow of ten hours.

Buildings.

The buildings are constructed of local made red and white bricks. The engine-room is 27 feet by 20 feet, office 11 feet by 9 feet 3 inches, stores 15 feet 9 inches by 9 feet 3 inches, boiler and destructor house 50 feet by 27 feet.

The whole of the outside work is faced with red bricks, with white Suffolk brick dressings. The inside throughout is of best white Suffolk facings, with glazed brick dado in the engine room and office. The engine-room, stores and office floors are constructed of cement concrete 12 inches thick, carried on rolled steel joists, and strengthened with a layer of expanded metal, which is placed in the centre of the concrete floor. The surface of floors in the engine-room and office is finished with marble mosaic, whilst that of the stores is finished with 2 inches of granolithic. The floor of the boiler and destructor house, lavatory, etc., is constructed with 10 inches of cement concrete, and finished with 2 inches of granolithic.

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Chimney Shaft.

The chimney shaft, which is eighty feet high, and five feet internal diameter at the top, is built of Coton Park Leicestershire bricks upon a foundation of cement concrete 18 feet by 18 feet by 5 feet thick. The stack is lined with fire-bricks which form an independent shaft to a height of sixty feet; the annular space of three inches between the outer and inner lining is being used as a ventilator for the collecting tanks. Two 15-inch pipes are laid as air-conduits from the top of the collecting tanks, immediately under the engine room floor, to the stack, and the rarefied air in the stack is expected to create a draught and induce a current of air to enter the tanks at the open end and travel through the conduits into the chimney cavity, where it will be rendered innocuous and be discharged from the top of the stack.

Pumping Machinery.

The pumping machinery consists of two pumps of the Worthington triple-expansion direct acting type, with attached jet condensers, made by the Worthington Company, each having—

Two high-pressure steam cylinders, each			5½	in.	in diameter.
„ intermediate	„	„	8	„	„
„ low-pressure	„	„	14	„	„
„ double-acting water plungers, each			12	„	„

All of 10 in. stroke.

Each of these pumps takes its suction from the main sump through its own independent pipe, and discharges in the main delivery to a point 40 feet above the pump room floor. Each pump when operating at its normal speed, is capable of delivering 600 gallons per minute, but in case of emergency can pump 800 gallons per minute.

It is intended to have one pump to act as a stand-by, so that in the event of any unforeseen accident occurring, the town would not be crippled for want of sufficient capacity.

Sewage Disposal Works.

The sewage disposal works are designed on what is known as the septic tank and double contact system. The works are situ-

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ate on sloping land 9 acres in extent, about half-a-mile from the pumping station. The rising main, of cast iron and 11 inches in diameter, is laid at such a gradient, and is provided with sluices so that it can be completely emptied at any time. This rising main terminates with a 3-feet bell-mouthed outlet, and the sewage discharges over the lip of the bell-mouth into a shallow chamber designed to minimise splashing.

From this inlet-chamber the sewage flows through two specially trapped inlets into duplicate grit chambers, where sand and other heavy mineral matters and detritus will settle. The water level in these chambers is retained by means of weirs which form the inlets to the biological tanks. The water level in the biological tanks is also determined by means of weirs 3 inches below the inlet weirs. The copings of these weirs are so designed as to prevent the lodgment of any solids on them. The tanks are built in duplicate, each being 45 feet long, 20 feet wide and 7 feet deep, having a storage capacity of 40,000 gallons, or 80,000 in the two; this is more than half the estimated dry-weather flow for twenty-four hours. The floors of the tanks slope to a point midway between the two, where a small sump is constructed from which pipes, governed by sluices, lead to a manhole adjoining the grit chambers. From this manhole a 9-inch pipe is laid to a point at a lower level in the field where a mud lagoon is formed. Into this lagoon all the mineral and other matter incapable of being liquefied which accumulates in the tanks and grit chambers, can be discharged and dealt with by trenching and digging in or otherwise.

From the biological tanks, the liquefied sewage passes over the outlet weirs into a feed channel, and is conveyed on to the "coarse" beds by means of Adams' patent timed feed inlet syphons. The sewage is so distributed, by means of wooden troughs, that each part of the bed will be filled at the same time. After a sufficient contact in the "coarse" bed the first filtrate is discharged, through Adams' patent automatic timed discharge syphons, on to the "fine" bed, the filtrate being distributed as in the case of the "coarse" bed, and after proper contact the final filtrate is discharged, by means of a second and similar discharge syphon, into the effluent channel. This effluent channel, which is constructed in cement concrete surmounted by blue brick copings, is so designed that in the event of the final

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filtrate not being sufficiently pure to discharge direct into the watercourse and thence to the river, it can by an arrangement of sluices be distributed over any portion of the land for further treatment. In the original scheme, the Author made provision for conveying the effluent from the land to the river and discharging it into deep water, but the Local Government Board thought that after treatment upon land this was unnecessary, and suggested that the effluent should be discharged into the nearest watercourse, although it is a very sluggish one, in fact practically dead level. Provision has been made for dealing with the storm-water, beyond three times the dry-weather flow of sewage. A storm-water filter 167 feet long by 77 feet wide by 3 feet 3 inches deep—area 13,000 superficial feet—has been constructed. The storm-water is conveyed on to this bed by means of a concrete channel direct from the chamber at the end of the rising main, and does not pass through the biological tanks, and is distributed over the surface of the filter by means of wooden troughs, as in the other filter beds. The walls of the biological tanks and the twelve bacteria beds, are built with blue Staffordshire bricks set in cement mortar and surmounted with bull-nosed coping of the same material. The floors are constructed with 12 inches of cement concrete and floated with ½ inch of cement mortar. They are all laid with a fall towards the outlet, and in addition thereto inverted channel pipes are laid on the bottom and covered with coarser material than the bulk in each bed, so as to facilitate the efficient draining of the beds. The bottom of the storm water filter is formed by merely excavating the soil to its proper depth and slope, and the soil so excavated was placed at the side to form an embankment, the filling to filter being put on the natural formation. The sides are covered with 6 inches of cement concrete, and open jointed drains are placed at the bottom of the filter, by which means the effluent can be drained off and discharged into the effluent carrier, as before described. The biological tanks are covered with galvanised iron sheeting, to shield the surface of the sewage from the wind, and so maintain quiescence in the tanks.

The selection of filtering material for the bacteria beds has necessitated a considerable amount of thought. Washed vitreous clinker would have cost about 1*l.* per cubic yard delivered on the site. This, as far as the Corporation of Sudbury is concerned, is a prohibitive price. Washed flint stone can be obtained and

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delivered on the site at a cost of 5*s.* per cubic yard, and the Author decided to use this as an experiment. It is proposed to work only three sets of beds at present, as these will be amply sufficient to treat the quantity of sewage that may reasonably be expected to reach the outfall for some time to come, as the scheme provides for an increase of 50 per cent. beyond the present population. Meantime the clinker residue from the destructor and also from the waterworks, will be accumulating at the rate of about eight or ten tons per week, and can be utilised for filling the remainder of the beds.

The total cost of the works when fully completed will be under 30,000*l.*; the approximate amounts for the various parts of the work being as follows:—

	£
Foul water sewers	10,500
Surface water sewers	4,000
Collecting tanks	1,800
Refuse destructor and proportion of buildings	2,800
Pumping machinery and proportion of buildings	2,600
Chimney stack	600
Rising main	1,000
Sewage disposal works, comprising biological tanks, bacteria beds, storm-water filter, under-drainage, carriers, etc.	3,600
	26,900
Land (about half-an-acre), site of collecting tanks and pumping station	450
Site (about 9 acres) for disposal works	600
Wayleaves, easements and compensation for surface damage, etc.	1,000
Engineering and miscellaneous expenses	800
	£29,750

The Author would like to express his indebtedness to Mr. J. T. Eayrs, M.Inst C.E., who as consulting engineer has rendered every assistance possible, and who has been most kind in many ways.

Thanks are also due to the Borough Engineer's staff present and past for the loyal way in which they have helped the Author, especially Messrs. Ernest E. W. Butt and J. Draper, both of whom have rendered signal service.

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DISCUSSION.

The PRESIDENT: I am sure we are very much obliged to the Author for putting together such a very interesting collection of facts. A great deal of the work we shall understand better when we have had an opportunity of going round and seeing it for ourselves. I beg to propose a vote of thanks to Mr. Hayward for his paper. Mr. Hayward refers to the earthquake which took place in 1884. I should like to know whether the other water supplies in the neighbourhood were affected in the same way as at Sudbury—whether the disturbance was widespread or local. Mention is made in the paper of an average of 25 gallons per head per day being sent down from the reservoir into the town. This does not strike one as being an abnormally large quantity, but I take it, from the remarks in the paper, that when this distribution was made there were very few water-closets in use. With regard to the large leakages which had to be coped with, do I understand that you have been able to save a waste of 4000 gallons per hour? That, with a total consumption of 175,000 gallons a day would work out at a little more than half the consumption of water. The cost of gas for public lighting and to private consumers, strikes me as being very high. But I suppose there are circumstances which I cannot appreciate, because living in the centre of a colliery district we get our gas considerably cheaper—for less than half the price paid in Sudbury by the private consumer. I agree with Mr. Hayward as to the provision of channels for macadamised roads. I regard no road as properly made up unless it is provided with a proper channel. As to private street works, the Council of course know what they are about, but I think they have acted very liberally towards the people who are responsible for making up the private streets in paying one-half the cost. Probably the Council considered that it would be to the advantage of the borough to have the streets made up and put in proper order, and that no doubt is the reason of their liberality. I shall be considerably interested in seeing the destructor, the heat of which is to be utilised for pumping the sewage. It is a thing which has been done in one or two other towns, and the heat is also used in some places in connection with the electric light works. As to

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the waterlogged ground, I take it that the remark in the paper does not apply to the whole of the main sewers, but to a certain portion of the work. Is this subsoil of sand and gravel somewhere about the level of the river and does the water filter therefrom? In reference to the syphon under the railway, I would like to ask the amount of drop, and whether there is any means of cleaning out the syphon? I think Mr. Hayward has omitted to mention the size of the collecting tanks.

Mr. J. T. EAYRS: It is mentioned on page 233.

The PRESIDENT: That is the storage capacity, not the dimensions. Then about the storm water. Is any storm water pumped or does it flow by gravitation, and are there any overflows provided in case the sewers become surcharged?

Mr. J. T. EAYRS: I should like the opportunity of seconding the vote of thanks which you have proposed to Mr. Hayward for his most interesting paper. There are certain points which have been set out by Mr. Hayward which are of peculiar interest to many of the Members. Of course, in an Association which numbers over one thousand, all the Members cannot be surveyors of large cities and towns like our President and others I see around me. Therefore the case of Sudbury is peculiarly adapted to Members who are surveyors of towns of from say 2000 to 30,000 inhabitants, because the works carried out will be specially instructive to them. I will commence with the statistical information. Mr. Hayward says, "the rateable value is low, and that is where any expenditure is most keenly felt." I rather take exception to that statement; as though it is correct, the effect of it as stated does not follow. I think Sudbury is to be congratulated on having a low assessable value, because it is probably saving large payments to the county from this cause. If the county is assessed at a higher level than they are they escape some of the duties which they owe to the county by reason of their low assessable value. Now it makes no real difference whatever to Sudbury in regard to their own municipal works whether the rates are high or low, provided the local assessments are on a uniform basis. If you have to spend 30,000*l.*, the payments of interest and principal on that amount will be a fixed sum. If you have a high assessable value the rate will be lower; if you have a low assessable value the rate will be higher. Therefore it makes no difference whatever to the ratepayers of Sudbury, except that by a

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low assessment in relation to the county, they escape county liabilities which they would otherwise have to pay. With regard to the works of water supply, the Members will notice that the loan for the waterworks is practically all paid off, and therefore the water supply in future will be all profit to the Corporation. I think that is a very satisfactory state of things. I also was very much struck by the falling off in the water supply owing to the earthquake. It is the first instance I have met with in which that reason has been given for a deficiency in the supply, and one would like to know more as to the effect on neighbouring wells and neighbouring supplies, especially Colchester, which I think suffered more than any other town in the district. A consumption of 25 gallons of water per head, though commonly put down as a figure of supply, is, I consider, really a very high consumption for domestic purposes. In Sudbury they have practically no water-closets or baths, and therefore 25 gallons per head is a very large amount. Of course they would want more water when they get all the water-closets at work under the new system of sanitation. I think Mr. Hayward is to be congratulated that by detecting and checking waste with the Deacon water meter he was able to reduce the consumption by one-half. That is another interesting fact which Members might make a note of. There is no deficiency in the supply; the people use what water they like, it is under constant pressure; and 12 gallons per head, as found by recording meters, seems to be sufficient. I know a place where they only have 8 gallons, and it is quite enough. The Members will also notice that the water department does not charge any of the other departments for the supply for street watering, for flushing and other purposes. In most places they have a debtor and creditor account, so that they know exactly what is the income from the water supply. As to the springs of water tapped near the sewage pumping station, I think the Corporation should not take a supply of water from such a point without very grave and careful consideration. I think the County Council are very badly advised in not declaring "main roads," and paying for maintaining them. No doubt before very long legislation will take place which will consolidate the present law as to main roads. When that comes about, West Suffolk may be in the unfortunate position of not having any main roads, and may consequently receive

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no Government grants, should any be made. With regard to private street works, it is quite a new feature to me to find that the Corporation have paid half the cost of making up streets. I have never heard of such a case in this country, and there must have been some influence of which I am not aware which brought it about. It may have been the desire of the Corporation to see all these streets well made up; but we know members of corporations are subject to influences at times to which surveyors are not. I would like to answer the President's question as to the syphon under the railway siding. It is a very short and simple one; the hydraulic grade would be 1 in 18 to 1 in 24, and giving a self-cleansing velocity; and if cleansing is required, a man may go down the manhole and put a rod through from end to end; while there is also an arrangement made for a 1000-gallon flush at the upper end of sewer. With regard to the collecting tanks at pumping station, the ground water level is about 14 feet above the level of the tanks, and 18 feet above the foundation. That shows the enormous pressure these tanks have to bear in order to prevent the ground water lifting the tanks, or leaking through the bottom of them. Without taking into account any friction which might arise, there would be 800 to 1000 lb. of pressure per superficial foot of surface. There were difficulties in making them watertight. The water did leak through the bottom at the partition wall of the tank, getting through the concrete and between the blue-brick lining and concrete wall, causing the lining to bulge. That has been remedied, the partition wall now being of blue-brickwork entirely, and the tank now, I am informed, is absolutely watertight. Those are some of the little difficulties which arise, and inevitably arise in works constructed in water-logged ground. The pipes used in the cast-iron rising main, I should like to inform the Members, were made in France and not "in Germany." I saw the pipes before they were laid. They appeared of good quality, and were delivered here cheaper than any English maker could deliver them. I think it is to be deplored that English cast-iron pipe manufacturers cannot compete successfully with their foreign rivals. These French pipes are a little longer than English pipes, being made on metrical lines, and no doubt contractors will appreciate that point as fewer joints are required. Members will notice that the cost of the sewers is extremely reasonable. I had no idea

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that the cost of the foul water sewer would come out so reasonable as 600*l.* per mile, including the cast-iron rising main. Those who understand the cost of sewers will admit that is very low. The surface-water sewers come out at 1000*l.* per mile. There is one other point I should mention, and that is with regard to sewer easements. There are a great number, a great deal of private ground being passed through. Those easements, I consider, were obtained on exceedingly reasonable terms. Mr. Hayward was fortunate enough to persuade the owners of property in over 96 per cent. of the cases to accept his terms, 1*s.* per lineal yard for sewer easements, 10*s.* for manholes, and 5*s.* for lampholes. I think the Corporation are to be congratulated upon Mr. Hayward having obtained such terms for them.

Mr. W. WEAVER: I wish first of all to support your resolution for a vote of thanks to the Author for the preparation of a very well thought out and complete paper. The first thing that strikes me in this paper is the financial difficulty that the engineer in a district of this kind must work under. Looking at the amount of the loans in proportion to rateable value, I am not at all surprised that the Local Government Board will not allow more money to be borrowed. The paper does not say what the rate in the pound is, but I should say it would be pretty considerable—someone says it is over 10*s.* in the pound. With regard to the public lighting, it seems to me that the town authorities are paying most exorbitantly for lighting the streets. 2*l.* per annum is charged for 1200 hours burning, that is something like 3¾ hours per night, so I suppose the lamps are extinguished early.

A MEMBER OF THE COUNCIL: They are not lighted in summer.

Mr. WEAVER: It is a most exorbitant sum to pay. I would suggest to the municipal authorities that they should put down a few meters and go in for the average meter system, which, in conjunction with incandescent burners, would effect a considerable saving. It appears to me the town are paying very dearly for their road metalling. I am paying in Kensington only 13*s.* a ton for Leicester granite, and Sudbury ought to get it cheaper than that. I would suggest that if Mr. Hayward cannot find an outlet for the whole of the clinker from the destructor in the bacteria tanks, possibly he might be able to

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pave his streets at a very cheap rate by pressing the clinker into blocks, mixed with a little Trinidad asphalt. I find they stand very well in places of this kind where there is little traffic. The town would then get the streets paved with the refuse of the dust-bins at a very cheap rate.

Mr. E. BUCKHAM: As to the foothpaths, I notice that Victoria stone slabs are used. I have had some little experience both in laying and making concrete pavement, both *in situ* and in blocks. In fact, I have been engaged, more or less, in doing such work for twenty-five years. Of course the circumstances vary in different towns; but my experience is that it is a great mistake to lay concrete *in situ*. For instance take Ipswich, the town which I represent. We are at the present time breaking up all our roads for tramways, and the footpaths for cables to carry the current. Several beautiful concrete paths which were laid *in situ* have been ruthlessly broken up the middle by the contractors for the cables. Of course they can be repaired, but they will never have the same appearance as when first laid down. If those paths had been laid in blocks we could have taken up the blocks and relaid them, replacing those blocks which were broken, and a week or two afterwards you would never have known that the path had been taken up for any purpose at all. I am very pleased to see you are taking the lead in one thing—that is the possession of a modern destructor. I think you have chosen wisely in putting down a Meldrum destructor. I have for several years past—at the request of my health committee—given a good deal of attention to refuse destructors, and though it is difficult to say without positive experience, yet I have felt that Meldrum's is one of the best. I am also pleased to see you have decided to utilise the power produced from the burning of the refuse for pumping the sewage. At Ipswich we are associating the destructor with the electric light works, and the surplus heat will be utilised for generating steam for electric light purposes. As to the drainage system adopted, perhaps Mr. Hayward will give some little explanation in his reply to the discussion. He states that the drainage is carried out on the partial separate system. Personally I am not an advocate for the separate system of drainage, unless it is in cases where you have to pump the sewage. In the two flat districts at Ipswich, with a population of about 10,000, we lift our sewage by the Shone system, and there it is important to

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separate the storm and surface water from the sewage; but in ordinary cases I do not see that there is much advantage in laying down two systems of drains. It complicates your system and adds to the number of pipes in your streets, and we have enough pipes in our streets without having two separate systems of drainage. You can in nearly all towns have storm relief sewers, and if you have such relief sewers one system is sufficient. I will only say one word with regard to the remark made by Mr. Eayrs—that he wondered our pipe manufacturers could not supply iron pipes at the same price as the French manufacturers. The answer is very simple. We have to pay our mechanics 30 per cent. more wages than they do in France and Germany.

Mr. A. D. GREATOREX: I should like to utter one word of warning. I notice Mr. Hayward proposes to experiment with flints, with which I agree, but I should like to warn him against the use of clinker from the destructor. My objection to clinker is that it breaks up, and the beds lose their capacity to the extent of 60 per cent. in a short time. He would save money by using a harder material at first. I do not agree with the principle laid down in Sudbury of the Corporation paying half the cost of making up private streets. It is not fair to the ratepayers generally, and one of the faults of the 1892 Act, and in my opinion quite sufficient to prevent any Corporation adopting it. Estates are cut up, private individuals make streets, run up houses and sell them, and leave the poor individual who buys the privilege of paying for the making up of the streets. It is not fair to the general ratepayers, because it is carrying out work which the landowner or the company owning the estate should do and pay for. Under the Act of 1892 however it is legal. Then as regards the price of gas for street lighting and domestic purposes, there is no doubt it is very high indeed, and there must be some reason why it is so high. To my mind the high price of gas fully justifies the Corporation of Sudbury in very carefully considering the carrying out of an electric lighting scheme; though where the cost of gas is reasonable it does not pay either for street or private lighting to use electric light against gas. Mr. Buckham has made some remarks as to the separate system of drainage. I cannot agree with him. Had he to deal with an excessive quantity of water on sewage disposal works on the bacterial system he would find it would mean a very big item. In my

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own case it would have cost the Corporation 70,000*l.* or 80,000*l.* if they had had to deal with the whole of the storm and surface water. We have to deal simply with the sewage, and that is going to cost us 21,000*l.* for the disposal works alone.

Mr. BUCKHAM: But the surface water need not come on to the beds. It could be diverted into a channel.

Mr. GREATOREX: Mr. Hayward has had many difficulties to contend with in the carrying out of the sewerage scheme. He has had to contend with waterlogged ground, which has made the tanks more expensive, but I am assured by Mr. Eayrs that the sewers are perfectly water-tight, and the work has been carried out in a thoroughly good manner.

Mr. C. CHAMBERS SMITH: Like most of the other speakers, I have been struck by the cost of public lighting. It appears to be very excessive to charge 2*l.* per annum for 1200 hours lighting, and I should like to ask whether that includes the cost of lighting and extinguishing the lamps, the up-keep of the standards, and cleaning. [A Member of the Council: it includes the cost of lighting and extinguishing the lamps.] At Sutton, where the lamps are lighted for 3600 hours, we pay 3*l.* 14*s.* per annum. That means lighting every day throughout the year from one hour after sunset to sunrise, and includes the cost of lighting and extinguishing the lamps, cleaning, the painting of the standards, and the renewal of mantles for the incandescent burners. I may say the town of Sudbury would find a very great improvement in their lighting if they were to introduce the incandescent lamp for street lighting. It seems anomalous that there are no main roads in this district. With regard to the use of Staffordshire blue bricks for paving the channels, I am inclinded to think the Council would find granite kerbs much cheaper in the end. As to the laying of concrete *in situ*, it is not to be recommended. It is much cheaper and better to lay concrete in slabs rather than *in situ*: you have the electric light, or the water, or the gas coming and breaking through the paths, and if they are laid *in situ* it is impossible to make a good job of their reinstatement. In making up all new streets in Sutton we are endeavouring to get the owners to pay a small proportion of the cost of planting trees. We get the owners to pay 2*d.* per foot frontage for tree planting. The trees are planted 30 feet apart, so for every tree we get a contribution of 5*s.* The consequence is that every street which has been

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made up in recent years has been planted. Our new streets are practically all boulevards, which is extremely popular, and the town will get the advantage of it in years to come. The weekly collection of refuse is most important, and if the town go in for portable ash-bins they will find a very great economy. As to the sewerage scheme, no mention is made of the ventilation of the sewers. Is it by surface grids or upcast shafts? The work generally seems to have been very efficiently carried out. One of the most important points is the material in the bacteria beds. I understand that for the coarse beds flints have been used. Flints are extremely good in their way, but I would say that a good hard vitreous clinker is preferable. You get a much better surface for the bacteria with a vitreous clinker than with washed flints. The Corporation of Croydon have recently put down washed flints, but they do not get such good results from them as from clinker. If you can get your destructor refuse thoroughly well burnt and vitreous it is the best material, but unless it is obtainable thoroughly well burnt I would advise you not to use it. I am taking out burnt ballast from the bacteria beds at Sutton because of its tendency to break down.

Mr. W. NISBET BLAIR: There is an important point referred to in the paper which nobody has touched upon, and that is the reform Sudbury has carried out in regard to its house refuse system. Ash-pits holding two or three months' refuse is about as abominable a system as anything that could be devised, and the sooner that is entirely abolished the better for Sudbury. I think the effect of that system is evidenced earlier on in the paper, where it is stated that the death rate is 18 per thousand per annum. That strikes me as a very high death rate for a small town in a healthy part of the country. The death rate should not be more than half that proportion, and probably you will find when you adopt portable dust-bins, and the weekly removal of refuse, that the death rate will go down by an immense drop. Sudbury is to be congratulated on altering the system, and I hope if we come back some years hence we may congratulate the town upon the results of the change in a reduced death rate.

Mr. REGINALD BROWN: I should like Mr. Hayward to include the zymotic death rate for the last ten years (Sudbury has grown very little in the last ten years), and you will probably

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find in future a large decrease in the deaths from zymotic disease following the adoption of the new sewerage scheme. I do not agree with Mr. Greatorex as to using clinker in bacteria beds. I am constructing beds now, and if you can get a good vitreous clinker it is a good material to use. I have two sorts of clinker, one from a London gasworks which is a thoroughly hard vitreous clinker, and the other from a local gasworks which falls into dust as soon as you get it. As to the price of gas, I support what has been said by previous speakers, that it is very excessive. I think if you were to adopt the 3 feet Kern burner in your streets it would cost very little more, and give a much better light. As to the system adopted for sewage disposal, there is no doubt that for Sudbury the septic system is a very good one; but it is by no means suitable for all cases, and each case must be dealt with on its own merits. I am going outside the ordinary lines. I am going back to the old precipitation system. I do that for this reason: we have a very large proportion of trade refuse coming to our works, probably 25 per cent. of our daily flow, one factory sending down a large quantity of fat, not in solution but in emulsion, and it is only possible to get it out by precipitation. In passing this stuff over bacteria beds we cannot pass it over a second day without raking off 2 inches of solid matter from the surface.

Mr. CAPON: I should like to ask whether the Local Government Board sanctioned the plan of turning the effluent from the beds direct into the stream.

Mr. H. GOODYEAR: I was very much surprised to see the statement in the paper as to the effect of the earthquake upon the water supply of Sudbury. At Colchester it increased the supply by 7 feet head in the well, but since then it has been gradually going down about 14 inches per year: and is now 26·6 below the then level.

COMMUNICATED REPLY.

Mr. HAYWARD: In reply, first of all I desire to thank the President and Members for their kind vote of thanks.

In reply to the President, the earthquake which occurred in Sudbury and neighbourhood in the year 1884, was more keenly felt in Colchester than in Sudbury, damage to buildings in the former town being considerable. The way it affected the

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water supply in both towns was somewhat remarkable. Up to the time of the earthquake the inflow of water through the bore-tube into the well at the Sudbury waterworks was in excess of what was required for use, and the rest level of the water in the well stood at, approximately, 90 O.D. and was never lowered however much was pumped. After the earthquake, however, the rest level of the water stood at, approximately, 80 O.D., and the inflow of water through the bore-tube was considerably reduced. This was probably due to an opening or fissure made in the chalk by the earthquake by which means the water got away and was distributed in the chalk at a lower level. It is a curious coincidence that at the time the rest water level was lowered in the Sudbury waterworks well, the rest water level in the well at the Colchester waterworks was raised several feet, so that what Sudbury lost Colchester gained. Twenty-five gallons of water per head was considered high for a town such as Sudbury where there are practically no industries which use very much water, and where only about half of the houses use water-closets, and this contention proved correct, for after the great waste, caused by leakages in the mains, was stopped, it was found that 11 to 12 gallons per head per day was about the average consumption. The diagram should be taken to read that 4000 gallons of water per hour were saved. The high price of gas is probably due to the fact that there has hitherto been no opposition in the way of public lighting; probably when the electricity scheme is taken in hand the price of gas will be reduced. As to the private street works, I advised the council that it was a mistake to pay such a large proportion out of the rates, but was overruled. The main intercepting sewers were laid in water-logged ground, the subsoil being sand and gravel through which the water percolated for considerable distances. The size of the collecting tanks, which are in duplicate, is 37 feet long by 12 feet 6 inches wide by 20 feet deep, but inasmuch as the sewers enter the tanks at a low level only about 10 feet can be used as storage, which gives an approximate storage capacity of 60,000 gallons. With regard to the question of conveying the effluent, after treatment on the land at the sewage disposal works, to the river, the Author had made provision for carrying it to a point where it could be discharged into the river in deep water, but the Local Government Board thought that this precaution was

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unnecessary and allowed the effluent to be discharged into a sluggish ditch close at hand, thus showing what faith they had in the proposed treatment of the sewage. Storm overflows are provided on the main sewers which come into operation when the sewers are carrying more than six times the dry weather flow.

In reply to Mr. Weaver, the Corporation are not altogether responsible for the high rates. The poor rate, over which the Corporation had no control, is, at the present time, 6*s*. in the pound. The Council has tried the meter system in regard to public lighting, but it did not work satisfactorily. In regard to the comparatively high price paid for granite, the heavy railway rates are responsible for that, as in Sudbury there was no opposition to the Great Eastern Railway.

In reply to Mr. Buckham, the reason for laying so much concrete pavement *in situ* was because of its cheapness of first cost. As regards the work the refuse destructor would be called upon to do, it was hoped that all the steam necessary for pumping the sewage would be generated by the heat derived from the burning of the refuse. The Author's reasons for adopting the separate system of sewerage were, (1) because of its lower cost, inasmuch as by so doing many of the existing brick sewers could be utilised for carrying off the storm water; (2) as all the sewage has to be pumped it would materially add to the cost of pumping if all the storm-water were taken into the foul water sewers; (3) the existing sewers were not deep enough to take the drainage from premises in many cases; (4) any subsoil water leaking into the old sewers would have to be pumped with the sewage, whereas the new sewers are all tested and watertight, receiving only sewage and partial rainfall. In regard to the remarks of Mr. Greatorex and Mr. Chambers Smith, it was decided to use flints as a filtering medium as an experiment. When clinker is used care will be taken that only the hardest portions are selected for this purpose. The sewers were ventilated by open manhole covers, and by shafts erected on private properties. It was found that blue brick channels cost considerably less than channels laid with granite.

In reply to Mr. Riley, the capacity of the sewage disposal works was based on the present requirements of the Local Government Board, both as to bacteria beds and storm-water

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filter, and allowance was made for an increased population of 3000. The present dry-weather flow of sewage has not been gauged, as in some cases it discharges into the river below water level, and in others into ditches, whilst a considerable quantity percolates into the ground and could not be measured. The amount (or volume) provided for in the sewers, also for pumping and disposal purposes, is based on 20 gallons per head per day, including trades waste. As to measuring the quantity of sewage flowing on to the bacteria beds, and the discharge therefrom, this can be done if found necessary when the works are in operation, but it follows that if the beds are watertight, there will be practically no difference in quantity, and the same will come out as goes in. As to the size of rising main, it was calculated for a discharge of 50,000 gallons per hour, or 833 gallons per minute, as the maximum duty at an economical velocity.

In reply to Mr. Blair and Mr. Brown, an extract from the Medical Officer of Health's report for the year 1902 is here given, which gives details as to birth and death rates :—

Births.—There were 155 births registered during the year, equivalent to a birth-rate of 20·5 per thousand of the population. The births and birth-rates in the borough during the past eight years were:

—	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Births..	180	177	129	187	156	150	158	155
Birth-rate	25·4	25·2	18·2	26·4	22·0	20·8	22·2	20·5

The average for the last ten years is 165·8 or 23·0.
The birth-rate for 1902 in England and Wales was 28·6.

Deaths.—The number of deaths from all causes registered in the district was 138, from which 24 deaths in the workhouse and Saint Leonard's Hospital from the rural parishes have to be subtracted, leaving the actual deaths as 114, equivalent to a death-rate of 15·7 per thousand of the population. The deaths and death-rates during the past eight years were:

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—	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Deaths registered ..	143	150	120	141	178	140	152	138
Deaths belonging to the District ..	111	125	96	113	146	116	129	114
Death-rate	15·7	17·7	13·5	16·0	20·6	16·4	18·1	15·7

The average for the last ten years was 122 or 18·0.
The death-rate for 1902 in England and Wales was 16·3.

Infant Mortality.—The deaths of infants under one year of age were 21, equivalent to the proportion of 130·0 per thousand births registered. The average for the last ten years being 115·2. The 1902 average for England and Wales was 133·0.

Zymotic Deaths.—Five deaths occurred, the causes being typhoid fever 2, whooping-cough 2, erysipelas 1. The zymotic death-rate for the past eight years was as follows:

1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
0	1·2	0·7	0·7	0·7	0·5	0·1	0·6

For 1902 in England and Wales it was 1·64.

Deaths from all other Causes and Ages.—Excluding the deaths of non-residents who died in public institutions, the following causes contributed to the mortality: phthisis 9, other tubercular diseases 5, cancer 11, bronchitis and pneumonia 16, heart diseases 19, accidents 2.

With regard to ages, there were: under 5 years, 25 deaths; from 5 to 25 years, 9 deaths; from 25 to 65 years, 35 deaths; over 65 years, 45 deaths; total 114.

Observations.—The above vital statistics show a slight falling off in the number of births, which is not satisfactory, the decrease in the number of deaths is. The infant mortality is, though, rather above the average.

The Mayor then entertained the Members to luncheon. At the conclusion of the luncheon, brakes were in readiness and the Members drove to the waterworks pumping station. The Members then inspected the new furnace which had lately been

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installed by Messrs. Meldrum of Manchester, where breeze was being burned in lieu of coal, and giving equally satisfactory results. The next place visited was the bathing place on the river Stour. The party then proceeded to the sewage pumping station and inspected the new buildings and pumping machinery. The sewage disposal works were then visited. At the Mayor's residence at Chilton Croft, the Members were kindly entertained to afternoon tea by the Mayor and Mayoress.

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ANNUAL MEETING IN LONDON.

June 25, 26, and 27, 1903.

THE PRESIDENT'S ADDRESS.

By William Weaver, M. Inst. C.E.

Recognising fully, with grateful appreciation, the honour conferred by the Members of the Association in appointing me their President for the next twelve months, I am at the same time fully conscious of the difficulties and responsibilities attaching to the duties of the position, and one of those difficulties I now confront in presenting this address to the Members of the Association, many of whom, with memories of the excellent essays of my esteemed predecessors, will, I apprehend, be able to bestow upon my present effort a critical appraisement probably the reverse of flattering.

My official experience of municipal work for over forty-three years has been confined to Kensington, and upon the statistics, work, and progress of that Royal borough I could dilate at length, as it represents my life's work, but as the paper read here in 1892 dealt fully with Kensington I reluctantly refrain from facile reiteration, and thus debarred I venture as the outcome of nearly half a century's experience to submit some observations on municipal work and its tendency, and I proffer for your thoughtful consideration certain views which occur to my mind as to the trend of such work in relation to municipal progress and national prosperity. Municipal progress and national prosperity are so interwoven that considerations relative to the former must of necessity have a bearing on the latter, and unless the trend of municipal effort

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harmonises with the unalterable laws which govern the advance or decay of nations, no real improvement in national life is achieved.

The directors, therefore, of municipal action should take a broad view of their responsibilities, and in their efforts to advance the interests of the particular locality with which they are connected, should consider the probable influence of their endeavours upon the national welfare as a whole. The individual effort of each unit constituting a nation has some effect, be it ever so small, upon the national life as a whole, and in the same way on a larger scale local effort affects the entire body politic.

A municipality or individual may with some degree of pride refer to work done, but unless that work is in harmony with the laws of Nature it simply amounts to backward progression. A Tower of Babel may be a monumental architectural effort with confusion for a capstone.

Glancing backward through the past forty to fifty years, one is struck with the growth and changes in this vast metropolis, London, and to many minds its continued extension in the future at the same rate presents a problem of the gravest character, and the same considerations apply in a minor degree to many of the large towns in the kingdom.

The changes which have been effected in the metropolis during the last half-century are stupendous, and there is every indication that the next half-century will present a similar record. Consider for a few moments the progress made in water supply, locomotion, roads, refuse removal, sanitation, and lighting.

Water Supply.

The public pumps, formerly the main supply in poor districts, are now almost unknown, and every house, as a condition of habitation, is furnished with a proper water supply, generally with constant service. The plan of abstracting from the river the water likely to overflow and cause damage, and storing same to meet times of drought, fully meets present necessities, and the enormous reservoirs and filtering beds between Staines and Hampton, and the extensions of the New River and East London Water Companies, will probably meet the requirements

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during the next forty years; and doubtless long before the expiration of that period the agitation for a new source of supply will be revived, more especially as the direction of affairs will be in the hands of the new Water Board instead of being vested in private companies. Under the present system, by which the higher assessed ratepayer pays more or less for the water consumed by his poorer neighbour, its use by the latter is encouraged, and extension of effort in this direction would result in individual and national gain.

The present policy of abstracting an enormous volume of water from the higher part of the river, and after passing through and serving the several purposes of the metropolitan community restoring same to the lower part of the same river, cannot go on for an indefinite period, otherwise the river would be pretty well pumped dry at its higher part and filled with sludge filth at its mouth.

In connection with water supply, the advance made in facilities for fire extinguishing is no less marked. The present fire hydrants present a contrast to the superseded plug (about which the turncock used to fumble to free a feeble dribble) as great as that furnished by the present steam fire-engine compared with the old hand-worked fire-engine in charge of the parish beadle.

Locomotion.

Great improvements have been effected in the facilities for intercommunication since the abolition of the turnpike trusts formerly charged with the maintenance of the main roads, and the standard of maintenance now demanded by the public, contrasted with the standard which satisfied the public fifty years back, affords a striking example of the advance in present-day requirements. Fifty years back steam road-rollers were not in use, and newly macadamised roads had to be consolidated by the traffic passing over same.

At the present time every patch of fresh-spread metal must be at once rolled in, or complaints as to damaged wheels are at once evoked. A smooth, consolidated macadam road no longer satisfies, but is being superseded by wood and asphalt paving. These two materials of various kinds, about which much has been—and still more might be—written, demand

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much more attention to fit same for the varying traffic, the different requirements of which furnish one of the many worries of the road surveyor, who looks forward to the extension of motor traction to relieve him of some of these difficulties. The partial or complete disappearance of horse traction will effect a vast improvement in the sanitary condition of streets, and will demand altered methods of road construction and lead to the universal adoption of impervious pavements.

At the present moment, however, the many advantages of motor traction are shadowed by the difficulties which always accompany any radical change; the roads constructed for horse traffic and used by the public accustomed to that traffic will have to be materially altered to suit motor traction, and such traction will have to be subjected to regulations enabling the general public to use the highways with safety and pleasure, privileges at present denied them owing to the extravagancies always attendant upon a new fashion. The enormous increase in the number of omnibuses on metropolitan streets has caused a large increase in the municipal rates arising from expenditure on road maintenance and street widening. Many of the most costly improvements (such as the Strand) would not have been necessary but for the omnibuses, and the passenger paying his penny for a ride should bear in mind that indirectly he pays considerably more than that for his journey. Anyone who carefully studied as I did the traffic of the streets during the omnibus strike some years back, must have been struck with their comparatively deserted appearance when denuded of the omnibuses. With proper regulations framed for motor vehicles as to speed, noise, weight, smoke, etc., motor traction should prove a great addition to the comfort of town residents, and the general adoption of such traction would be equivalent to widening the streets owing to the lesser requirements of the changed traffic.

Tramways—conduit, overhead, and surface contact—are now common, and deep tube railways electrically worked are in operation, and further schemes are under the consideration of Parliament.

With reference to metropolitan locomotion, extreme caution is desirable; the various evils connected with the present tube railways should be cured, or the practibility of the cure demonstrated before others are allowed to be made; and,

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with regard to tramways, before incurring enormous loans, municipalities should consider first the possibility of their populations decreasing instead of increasing, and, secondly, as to the possibility of motor traction rendering tramway tracks unnecessary.

Refuse.

The collection, removal, and disposal of the refuse of the metropolis is a gigantic work, and the excellent manner in which it is on the whole carried out, is an important factor in the preservation of the public health. The work so far as it relates to house and street refuse, is generally carried out by the municipal authorities themselves, and of necessity is costly, but the expense could be much reduced if ratepayers would assist in lessening instead of increasing the difficulties of the work.

In Kensington the rates would be about a penny in the pound less if paper, straw, cardboard, etc., were burned instead of being thrown into dustbins or cast upon the streets. Although many attempts, some attended with a degree of success, have been made to utilise the street refuse, it is, as a general rule, deposited in excavations or on low-lying land. With regard to house refuse, it may be taken that its general destination is a refuse furnace, and the gradual evolution of ideas connected with the utilisation of the heat generated therein and the cremated residue therefrom forms an interesting chapter in municipal engineering. Of course, the power evolved and the residue rejected from the furnaces varies with the character of the refuse put in; but inasmuch as the subject of refuse and refuse furnaces has received exhaustive detailed treatment in many papers read before this Association, it would be waste of time for me to dwell on this subject, but I might state incidentally relative to the utilisation of clinker residue, that the experimental clinker paving blocks which I laid down at Earl's Court in June 1902, are wearing remarkably well, and I hope to be able to pave the roads of Kensington with an impervious pavement manufactured from dustbin refuse, and thus save the expenditure on wood blocks and asphalt.

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SANITATION.

In no branch of municipal work has greater advance been made during the past half century than in sanitary work. The universal cesspool has been displaced by water-carried sewage schemes, and old brick drains have given way to stoneware and iron pipes. The regular removal without nuisance of the sewage of the metropolis is an enormous work, and the system provided is possibly the best that could be devised. The occasional flooding of basements by storm water in certain districts is the chief drawback, and owing to the practical impossibility of constructing any separate surface-water system in the metropolis, the storm relief sewers and additional pumping stations from time to time constructed by the London County Council seem to be the best means of coping with this difficulty.

The best means of dealing with the offensive exhalations from the sewers remains a vexed question: on the one hand, we have the unanimous opinion of the metropolitan supervisors of drainage work condemning the siphon traps as the root of the nuisance, and, on the other hand, the medical officers of health responsible for the introduction of such traps insisting on their use on each house drain as an essential requisite, a view endorsed by the recently issued drainage bye-laws of the London County Council.

The difficulty thus created in antagonism to their own recommendation is left with the engineers to solve, and various remedial measures have been suggested. Free diffusion and aeration, confinement, mechanical extraction, combustion, filtration, and chemical treatment, each has its advocates, and many papers have been read and many discussions have taken place relative to the different theories and systems propounded. Personally, I am strongly in favour of the view taken at the conference of the metropolitan surveyors at the London County Hall, presided over by the engineer of the Council—viz. that surface gratings should be closed wherever a pipe shaft can be carried up an adjacent building, and in all cases where a siphon is inserted in the main house drain a ventilating pipe should be carried up from the sewer side of such trap. By these pipes each house would assist in the detail solution of the difficulty

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which it helps to create, instead of passing it on to the sanitary authorities to be dealt with in bulk at great cost.

The present-day supervision ensures the proper execution of all drain work and an adequate water supply to each house, but the construction of buildings in accordance with the provisions of the London Building Acts is supervised by district surveyors appointed by, but only partially responsible to, the London County Council. One of the pressing needs of the metropolis is the transfer of the district surveyors' duties to the borough councils, who should be entrusted with the duty of seeing that the buildings erected in the boroughs should not only be properly drained, but also that they should be properly built and otherwise safe and fit to live in.

One of the most striking features in the evolution of metropolitan sanitary administration during the past forty-five years, is the extraordinary change in the status and duties of the medical officer of health and inspector of nuisances. Formerly the duty of the former was to keep, as it were, his finger on the public pulse and report on the fluctuations of the public health, and the duty of the latter was to seek out nuisances of all descriptions and report same for treatment. The former has now developed into an official closely resembling a minister of public health for his district, not only calling attention to the health drawbacks therein, but suggesting the nature and extent of the remedial works required, involving an amount of practical building and engineering knowledge possessed formerly by very few medical men. The inspector of nuisances has developed and multiplied into the *sanitary* inspector — so misnamed because his work is limited to *insanitation*—and in my opinion there is no body of public servants in the metropolis capable of doing more good for the community than the sanitary inspectors, provided they are properly controlled and looked after, so that the danger may be guarded against of over sanitary zeal, whilst lengthening life, simultaneously reducing the means of living.

In connection with the sanitation of buildings, not only has there been a revolution in sanitary fittings, but the types of buildings themselves have completely changed, and many workmen's dwellings at 25*l.* or 30*l.* rent furnish architectural and sanitary accommodation lacking a hundred years back in houses of treble that rent. The evolution of residential flats is another marked feature, but whether the change is an improve-

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ment from a sanitary point of view is doubtful. Overcrowding, whether vertical or horizontal, on any area of ground, is objectionable, and in vertical crowding, as in an eight-storied block of flats, it must not be lost sight of that the vertical permeation of smells and dust is more direct that the diffusion from one-storied dwellings even when crowded together. Many high-class blocks of flats will show a larger population per acre than many slum districts.

Lighting.

The contrast between the rushlights and tallow candles (cotton dips) of fifty years back and the electric light of to-day affords, perhaps, as striking an example of the advance in comfort as any of the changes effected during the half-century. Gas was a vast improvement on oil, and is still making a strong fight with electricity as an illuminant, but its supersession in that direction, I think, is certain, and its profitable use will have to be found in its extension for heating purposes to the lessening of the smoke nuisance.

General Observations.

Having touched upon some of the most important changes in municipal work during the past, let us now consider the trend of municipal progress and some of the problems awaiting future municipal treatment. The large towns throughout the country without doubt have their tasks of difficulty, but they sink into insignificance when compared with the problem set by the metropolis. With the preferential liking for pleasure *versus* work generally attaching to humanity, the individual is naturally attracted to the locality where he can get most of the former with as little of the latter as possible, and nowhere are these chances or conditions so favourable as in the metropolis. The magnificent waste and luxurious benevolence prevalent there offer chances of living without work not to be found elsewhere, hence the thousands of loafers to be found throughout all the public parks on a fine day, who, as a rule, find little difficulty in subsisting during the greater part of the year, and during the other part swell the ranks of the unemployed

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to the unwarrantable augmentation of the difficulties of that question—difficulties which demand the gravest consideration.

At a conference on the unemployed question held in February 1903, it was suggested that by the proper training of children the present difficulties would almost disappear in one generation; but I submit as a condition precedent to accepting this theory it must be assumed that the children are properly made. Many human beings are like bad castings, only fit for the scrap heap, but they have unrestricted licence to propagate offspring to the physical and financial detriment of the nation. Whether the present-day philanthropic strivings for universal contentment, happiness and peace will, if perfected, prove an efficient substitute for past brute force advancement, is open to doubt, involving, as it does to some minds, the reversal of the law of the survival of the fittest.

Inventing unnecessary work in order to give employment and thus stop clamour is the worst solution which can be profered for the unemployed problem, as it increases the evil instead of lessening it. As climatic conditions, upon which the difficulty almost entirely hinges, cannot be altered, the remedy must be sought in directions independent of weather, and if the country life pursued by many of the poor during a large portion of the year could be extended to the remainder of the twelve months it would be advantageous all round.

The gradual concentration and fostering of the unfit means rapid national decadence, and unless measures are adopted for getting the people back to the land the physical deterioration now going on must result in England's retirement from the forefront of the nations. Should such *reflux* of population occur, a large part of municipal indebtedness now being incurred to cope with the *influx* will be money wasted with the capital secured upon a rapidly reducing rateable value, with the result, despite sinking funds, that the nationalisation of municipal loans will offer the only means of preventing in many cases municipal bankruptcy. An increase during the past twenty-six years of 216 per cent. in local debt deserves the gravest consideration, and an alarming feature connected with this indebtedness is the immense amounts expended in dealing with lunacy. Gigantic asylums are constantly being erected and are filled as soon as built, and on the lines on which we are advancing there seems a probability at no

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distant date of a large proportion of the entire population having to be supported in public buildings of various kinds at the expense of the overworked and overtaxed remnant. It is impossible for me here to do more than allude to this problem gravely affecting national vitality, but Members may, if they so desire, glean some useful information from the paper read before the Society for the Study of Inebriety on July 15 last by Dr. Jones, physician and superintendent of the London County Asylum, Claybury.

In burdening posterity with heavy liabilities, due consideration should be given to the possibilities of the future creating financial demands at present unthought of, and in dealing with the financial requirements of the present, speculative burdens which may hereafter prove dead loads, should not be piled up.

Another danger attaching to the lines of municipal progress lurks in the direct labour question. With an experience of about equal duration of contract and direct work, I find contract work generally much less expensive, but as a rule not so well executed as when carried out by direct labour. The reduced excellence of the work arises from the natural disposition to increase profit at the sacrifice of excellence, and the increased cost of the directly executed work arises chiefly from the difficulties attaching to municipal labour. Apparently vested with absolute control, the engineer or superintendent at the head of the work encounters such subtle influences in the interests of the workmen adverse to economical administration as renders it impossible to obtain the same amount of labour for wages as a contractor would succeed in getting, and that without sweating his men. Influences all tend to add names to the municipal workmen's list and to create difficulties in getting them off when once added, and hence it arises to a great extent that municipal work has to be found and fitted to the men, whilst in contracting the men are discharged and changed in accordance with the fluctuations and demands of the work.

In municipal as in national work the power of combined labour is making itself felt naturally for the advancement of its present interests, but possibly to the future detriment of the commonweal. So long as any body of workers can by their votes secure representatives on councils and in Parlia-

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ment they will to some extent dictate the terms of their employment, and thus it happens that throughout the country a body of workers is being created with privileges denied to the outside ranks, a state of things either unjust to the latter or preferentially unfair to the former.

Some of the points hereinbefore alluded to would not have formed part of my address had I allowed personal policy to outweigh a sense of duty, possibly erroneous, but, at any rate, conscientious. I have a very strong feeling that the competitive efforts of the large towns, whilst probably conducing to the present prosperity of each, are antagonistic to the future welfare of the country as a whole, and must result in a decadent population, deficient in the virile merits necessary for a country's advancement in the conflict of nations.

In municipal matters, as in national affairs, the preponderating vote of the elective units decides the policy of the elected body. Each municipal council, therefore, determines the broad lines of its work, having due regard to the statutes, and it rests with the officials to carry out the municipal work on the lines so laid down, taking special care to get, as far as possible, proper value for money expended. Such, doubtless, is the primary duty of the official; still, at the same time, he should not, from personal considerations, shrink from submitting his views, backed up by facts and experience. It should be borne in mind that municipal bodies are constantly changing, and members making mistakes can quickly retire from the scene, but the official remains and has to face the results, and perchance bear the blame of mistakes committed in opposition to his judgment and advice.

In a recent return it was stated that the loans raised by local authorities in England and Wales during the past twenty-six years amounted to close upon 320 millions sterling, and when we consider that the greater portion of that sum has been spent under the supervision of Members of this Association, some idea may be gathered of the responsibilities discharged by them. Upon those responsibilities I would urge Members to devote all their skill, coupled with zeal and integrity, both for the credit of our profession and in order that we may, at the end of our life's work, experience the satisfaction of having done our duty.

In concluding my observations I take this opportunity of

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adverting to the continued advance of our Association, which now numbers 1034 Members of all grades, and I venture to express the hope that each Member will do his best to promote the welfare of the Association so that its future may compare not unfavourably with the past. This duty rests more especially with the younger Members, whose zeal and energy, united with the riper experience of the older Members, should effectually surmount the difficulties which doubtless will strew the future path of progress, and I would urge upon the former to contribute papers and take an active part in the discussions. Their efforts will be welcomed in that spirit of professional brotherhood which so closely unites the Members in the ties of friendship.

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THE EXPERIMENTAL BACTERIAL TREATMENT OF LONDON SEWAGE.

By Professor FRANK CLOWES, D.Sc. (Lond.), F.I.C.

Introductory.

The London County Council is the authority which is responsible for dealing with the sewage of London. Before the Council was created, the responsibility rested with the Metropolitan Board of Works.

The crude sewage was originally discharged at various points into the Thames within the London district. This method of disposal led to very serious nuisance. The solid fæcal matter from the sewage was deposited during the cooler weather upon the river bed and the foreshores. When higher temperatures prevailed, this solid fæcal matter underwent change, which owing to the exclusion of air, and to the absence of dissolved oxygen in the river water, was of an offensive putrefactive nature. The foreshores were highly offensive in summer-time for this reason. But the putrefying masses, borne up by the gaseous matter which they were emitting, also floated on the river surface, carrying foul smells up and down stream as they were drifted by the ebbing or flowing tide.

The offence caused by the solid fæcal matter was prevented by constructing a system of intercepting sewers, which delivered the whole of the North London sewage fifteen miles down stream to an outfall at Beckton, on the northern bank of the river, and the whole of the South London sewage at an outfall at Crossness, somewhat further down stream on the southern bank of the river. The sewage arriving at these outfalls was subjected to screening, and then to a process of sedimentation by being passed slowly through long and capacious settling channels. The effluent passed direct into the river, whilst the

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sediment, or "sludge," in a semi-liquid condition, was disposed of by being carried out into the estuary in tank steamers, and allowed to flow out from the tanks on the ebb tide.

The sewage is still treated in this way. It receives an admixture of chemicals, which at present consist of small proportions of solutions of sulphate of iron and of lime. These are added before it passes into the settling channels. The addition of these chemicals promotes sedimentation, and lessens the emission of foul gases, but the amount of chemicals added has been reduced as low as is possible to combine economy with the above objects.

The present treatment has entirely removed the nuisance arising from foul foreshores and from floating fæcal matter; but when it was adopted, a warning was issued that dissolved invisible putrescible matter would remain in the effluent, which could only be removed by treatment on land or by other methods. The bacterial treatment of the effluent on the land was found to be impracticable, as the low-lying marshy ground in the neighbourhood of the outfalls was found to be quite unsuited to receive the large amount of liquid discharged from the London sewers. But when the controlled bacterial treatment of sewage in suitable beds or tanks was shown to be successful by the Massachusetts experiments, the London County Council at once adopted the recommendation of their Chemical Adviser, and started on an experimental scale the controlled bacterial treatment of a small portion of the London sewage.

General History of Experimental Bacterial Treatment.

The bacterial treatment of sewage in reality commenced with the experimental filtration of sewage through various natural soils, which was carried out in the laboratory of the Royal Commission on Rivers Pollution. It was found that when, under laboratory conditions, the different permeable soils received alternately a flow of sewage and a flow of air, sewage effluent of a satisfactory nature was obtained. It was not known at that time, but it has since been abundantly proved, that the purification of the sewage was not due to any quality inherent in the soil, since stones and coal are equally efficacious, but was due to the presence of bacteria in the soil, or to

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their introduction into the soil from the sewage. If these bacteria are occasionally supplied with oxygen, they are able to inoffensively break down the complicated substances in the sewage, and thus to prevent them from subsequently undergoing offensive putrefactive changes.

The purification of sewage by intermittent "land treatment" is, in reality, a purely bacterial process. It was largely adopted, and many so-called "sewage farms" were laid out for this purpose. Where the soil was of a suitable character, and the farms were suitably laid out and properly managed, the treatment has been successful. But difficulties arising from unsuitability of soil and from other conditions, and the large areas required by the greater centres of population, have restricted the application of the "land treatment" of sewage.

But when it was shown by the Massachusetts experiments that, by placing the action of bacteria under regulated conditions, their purifying action could be exercised with regularity, certainty and precision, and, moreover, that the area, space and time requisite for their purifying action could be vastly reduced, it became manifest that the purification of ordinary domestic or town sewage by natural or bacterial means could be made universally applicable.

Summary of Experimental Work of the Council.

The London County Council commenced its experimental treatment on these lines in May 1892, under the advice and superintendence of my predecessor. These early trials, on a small scale, were eminently successful, and they led to the construction of an acre coke-bed at Beckton in 1893. This bed is still in operation, treating intermittently the effluent from the settling channels. The effluent which is discharged from this bed shows an average purification of over 90 per cent., as compared with the original sewage, the purification being measured by determination of the amounts of putrescible organic matter present as measured by the oxygen which this matter takes from permanganate.

This experimental work came under my direction in September 1898, and I have to acknowledge the very effective carrying out of the experimental work by the Assistant Chemists at the outfalls (Messrs. J. W. H. Biggs and E. B. Pike), and the

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co-operation of the Superintendents (Messrs. Beal and Stokoe). Experimental brick and iron tanks, of smaller dimensions, for the reception of fragments of coke and other materials, were at once brought into use, and it was decided to settle, amongst other questions: (1) What appeared to be the most suitable material; (2) whether there was any limit of depth of bed; (3) whether crude unsettled sewage could be treated; (4) what were the advantages of preliminary sedimentation; (5) whether the effluent was aërated and permanently non-putrescible; (6) what was the permanency of the purification and of the beds; and (7) whether intermittent treatment was the most suitable means to be adopted. The general results were as follows:—

1. *Material for Forming Bed.*—It appeared that hard coke gave a somewhat higher degree of purification than any other material. It was used in fragments of about the size of a walnut.

2. *Depth of Bed.*—The depth of a particular bed was gradually increased from 4 feet to nearly 12 feet, and the purification effected was carefully measured. It was found that a somewhat better purification was obtained as greater depths were reached. It was evident that there was no advantage in limiting the depth of the bed, and this is of great importance where land is expensive. Further, it was found that even the 12-foot bed became readily aërated in the resting intervals between the fillings.

3. *Treatment of Crude Sewage.*—For some time the beds were supplied with unsedimented sewage, and were found to yield a satisfactory effluent. But the capacity of the beds rapidly diminished during this period, and on examination the coke was found to be coated with grit from roadway wear and tear, and with chaffy matter derived mainly from horse dung. The treatment of crude sewage was therefore stopped, not because it ceased to be purified, but because the capacity of the beds became seriously reduced.

4. *Treatment of Sedimented Sewage.*—In later experiments the sewage was passed through a settling tank of such capacity that its passage through the tank required five hours. The inflow and out-flow pipes dipped below the surface of the contents of the tank, so as to secure non-disturbance of its surface. The settlement of the sewage which took place in this tank prevented altogether the choking of the coke-beds. It was found

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that the uncovered settling tank formed a scum upon its surface which, when unbroken by wind or rain, often attained considerable toughness and thickness. This covering of scum had some advantages, but was by no means necessary. Arrangements were made for measuring accurately the suspended matter which passed into this tank in the sewage, and the amount which remained at the bottom of the tank after six months' working. It was found that an average of about 50 per cent. of the sediment had been resolved by bacterial action into the gaseous and liquid state. This is an important reduction in the amount of the sludge, and the decrease would be undoubtedly larger still if grit and mineral matter had been prevented from entering the settling tank by the passage of the sewage through preliminary grit chambers.

5. *Condition of the Effluent.*—The effluent flowing from the coke-beds was found to contain and to retain dissolved oxygen. This was proved by chemical examination, and by the fact that fish lived in it for long periods. The effluent was also examined by exposing it in an incubator for many days to a summer temperature (80° F.); it was found to remain inoffensive under this severe test.

6. *Permanence of the Material and of the Purifying Power of the Beds.*—The hard coke used in some of the small experimental beds has been in use for four years, and appears to be still in every way suitable for use. The purifying power of a bed seems to rather increase than to diminish with the age of the bed, provided the bed is worked in a rational and proper manner.

7. *The Advantage of Intermittent over Continuous Treatment.*—The method of using the beds has usually been that known as intermittent. When they have been fully worked they have received four fillings in the twenty-four hours: this means that the bed has been filled with settled sewage in about an hour, the sewage has remained in the bed for two hours, it has then been allowed to flow away from below and empty the bed in about an hour, the bed has then been left full of air, or "resting," for about two hours. The above cycle is repeated three times in the twenty-four hours. The results obtained in this way were compared as regards the degree of purification effected, and the amount of sewage disposed of in the twenty-four hours, with the method of continuous feed, in which the sewage never filled the bed, but continually entered at the top and flowed away

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from below. It was found that when a corresponding degree of purification was effected, the amount of sewage dealt with by continuous feeding was considerably less than that dealt with by intermittent feeding.

8. *General Conclusions.*—It was concluded, from the experience obtained from these experiments, that, provided a settling tank and coke-bed bacterial plant is properly constructed and properly worked, a very uniform and satisfactory purification of the sewage is effected, and a very large proportion of the suspended matter is disposed of; and further, that the process is one which requires little cost in maintenance. A purely domestic sewage, when treated by these processes, was found to yield no sludge.

Conclusion.

An attempt has been made, in preparing this paper, to give a summary of the most important results which have been obtained by the Council's experimental work. The detailed statement would necessarily be of a very lengthy nature. But it should be mentioned that the London County Council has decided to publish in book form an account of this investigation; this treatise is already in the press, and it is hoped that the Council's object in publication will be attained, and that the book will be found of considerable use to those on whom the responsibility rests of dealing with the sewage of our centres of population.

DISCUSSION.

Professor Henry Robinson: I beg to propose a hearty vote of thanks to Professor Clowes. The paper contains the following paragraph: "But when the controlled bacterial treatment of sewage in suitable beds or tanks was shown to be successful by the Massachusetts experiments, the London County Council at once adopted the recommendation of their Chemical Adviser, and started on an experimental scale the controlled bacterial treatment of a small portion of the London sewage"; and also the following paragraph: "But when it was shown by the Massachusetts experiments that, by placing the action of bacteria under regulated conditions, their purifying action could be

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exercised with regularity, certainty and precision, and, moreover, that the area, space and time requisite for their purifying action could be vastly reduced, it became manifest that the purification of ordinary domestic or town sewage by natural or bacterial means could be made universally applicable." The inference to be drawn is that the County Council followed the lines laid down by the Massachusetts Board, whereas it is not so. I desire to point out that the results of the experiments of the Massachusetts State Board of Health led to conclusions which I have summarised at pages 161 and 162 of my book on 'Sewerage and Sewage Disposal,' thus: "During 1890, sewage was filtered through a bed of washed gravel stones five feet deep. For nine months sewage was applied nine times a day for six days in the week, in quantity equivalent to 81,400 gallons per acre per day (or 70,000 gallons per acre per day all the year), with the result that 98·6 per cent. of the organic matter in the sewage was converted into nitrates, and more than 99 per cent. of the bacteria were destroyed. The quantity was then increased by applying the same amount hourly for fourteen, instead of nine, hours. This was equivalent to 126,000 gallons per acre per day for six days in the week for three months, ending October 24, when 98·5 per cent. of the organic matter was found to have been converted into nitrates, and more than 99·6 per cent. of the bacteria were destroyed. In November the quantity was again increased." The following paragraph is one to which special attention is directed: "The experiments with gravel stones afforded the best illustration of what takes place in the purification of sewage. The slow movement of the liquid (even with the coarser suspended matters contained in the sewage) in thin films over the surface of the stones in contact with air caused 97 per cent. of the organic nitrogenous matter—a large part of which was in solution—as well as 99 per cent. of the bacteria, to be removed during a period of some months. There remained in the effluent only 3 per cent. of the decomposable organic matter of the sewage." I hope that what I have pointed out will not go unheeded by those interested in the County Council outfall works. They have opportunities of conducting experiments which would be of value to all of us, and in showing that what has been done is not following up the Massachusetts experiments. It is not with a view of offering captious criticism, but of getting them to adopt and develop

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the system which the Massachusetts State Board pointed out gave the best results, instead of continuing to follow a course at variance with it. If you take the trouble to refer to the Third Report of the London County Council, you will find that the conclusions published by Professor Clowes and Dr. Houston are absolutely at variance with each other. I will not trouble to read them. You may take it as fact which is borne out by the report, that whereas one of the experts claims that the "contact bed" is absolutely successful, the other points out that "the effluents from the bacterial beds cannot be reasonably assumed to be more safe in their possible relation to disease than raw sewage slightly diluted, but otherwise unaltered in its bacterial composition." I am speaking in the presence of many who are interested, like myself, in the sewage question, and they will agree with me that the literature proceeding from the London County Council, and from the Commission on Sewage, during the last few years, instead of assisting us, has caused embarrassment and confusion, coming as it does from authorities whom we had hoped and expected would have given us some practical results of value. I am of opinion that the "contact bed" method is not one which will be in use many years longer, though large sums of money have been spent in the past, and are proposed to be spent now. I am of opinion that the "percolating" system in the presence of air, which the Massachusetts Board found the best, and which I have adopted in my own practice, will be found the most efficient and the most economical. I do not intend to refer to the Sewage Commissioners' Report beyond saying that what they have done in the past has not been as helpful to engineers as was hoped for, and we all feel that the Commissioners should devote some of their time to dealing with practical engineering matters, instead of publishing blue books containing masses of evidence and investigations, which could be characterised as having but little, if any, bearing on the sewage problem that the Commission was appointed to investigate.

Mr. C. H. Cooper: In seconding the vote of thanks, I regret I have not had an opportunity of carefully reading Dr. Clowes's paper, but in glancing at it I am rather surprised that he advocates an increase in the depth of filtering beds. When one gets careful analyses taken from the different depths of such beds, as was done by the Massachusetts State Board, he will find that

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by far the greatest amount of work is done at the surface. In the bed at Barking, as formerly worked, the water was only allowed to rise to within a few inches of the surface, so that no surface work took place with such experiments. I do not wonder at Dr. Clowes coming to the conclusion that if he deepens his bed he will get an equivalent amount of purification for every foot in depth. To my mind that is totally erroneous, if you take into calculation the work done at the surface. What is the use of the various systems which have been devised for distributing the sewage over the surface of beds in the form of a spray? It is, that the sewage is partly aërated before it comes on the bed. At the surface the sun, the wind and the air, all help in the treatment. As to arresting grit upon entering the sewers, can you get a more expensive means of getting rid of such grit than that adopted here in London, where it has to be loaded into carts by hand out of the catchment pits of the street gullies, and carted, perhaps for miles, to a tip; whereas, by allowing the grit to enter proper sewers, it would be carried away with the sewage to Barking or Crossness, when it would add, of course, to the sludge, and cost, perhaps, 2*d.* per ton to barge it out to sea; but if collected in the streets it possibly costs 10*s.* per ton. I think that is one of the great mistakes of London government in having the sewer authority separate from the street authority. You get the sewer authority preventing every bit of grit going into the sewers, instead of its going down to the outfall and being dealt with at the least cost.

Mr. E. J. SILCOCK: There are one or two points with regard to the paper which I think should be dealt with to-day, more particularly because, coming from the source which they do, the views put forward will be looked upon as being largely authoritative. First of all, with regard to the material to be used in contact beds. The Author says that the best material to use is coke, and he asserts that the degree of purification obtained by coke in London has been in excess of the degree of purification obtained by any other material. I venture to think the experience in London is not the universal experience. Other materials have been tried in other places, and the degree of purification obtained has been quite as good as from coke; and we know there are very great drawbacks in the use of coke, because it breaks down and becomes smaller in size with age. The Author says that for four years the coke used at Barking

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has not deteriorated in size. The coke used must be of an exceedingly good quality to stand for four years without disintegration. I believe that a harder material than coke will prove the more economical material for making contact beds. The next point is with regard to contact beds *v.* continuous filtration. The Author has not been good enough to give us any evidence on which he bases his conclusion that contact beds are better than continuous filters, but to convince us he will have to give us something more than a bare statement of opinion. Contact beds do, undoubtedly, lose capacity. Those who have had any experience with contact beds will know that, even with a septic tank of greater capacity than that mentioned by the Author—five hours' sewage capacity—there is a certain amount of material going into the contact beds which, after being acted upon in the beds, becomes inert, and remains in the beds and reduces their capacity. The advantage of the continuous filter is this: by having the material of a very much larger size than in contact beds, this inert material is washed through the filter, and the latter does not lose its capacity, but goes on purifying the sewage without depreciating in value. That is a strong point in favour of the continuous system, and the results of experiments which have been carried out, prove up to the hilt that the degree of purification obtained by continuous filtration is at least equal to that obtained by contact beds. I should like to say one word as to continuous filtration on a system on which there shall be no septic action to precede the continuous filter. Hitherto it has been assumed that for continuous filtration the septic tank was a necessity. It was, I think, a debatable question whether any septic action was necessary in the case of contact beds, because it is not quite clear that the anaerobic organisms do not carry on some action in those beds. But it has hitherto always been considered that, for a continuous filter, it was necessary to have the septic process to precede it. The objection to that is that the septic process is likely to cause a nuisance from smell, and therefore, for certain positions, the septic tank cannot be used. From experiments which have been carried on at the Leeds sewage works now for some time, it has been proved that the continuous filter, without any septic action at all, will give good results in the way of purification. The sewage is taken direct from the outfall sewer on to the distributors, the only preceding treatment being screening. The

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screen used is one of a very fine mesh. It is desirable to screen out as much as possible of the suspended matter in the sewage; that tends to clog up the top surface of the continuous filter. If that is removed by a screen before the sewage is applied to the filter, better results can be obtained. That filter has now been working for a considerable time, and giving excellent results. The effluent contains considerable quantities of matter in suspension, which gives the appearance of a clouded effluent, but that matter in suspension is thoroughly oxidised and is non-putrescible, and there is no reason at all why it should not be allowed to be turned into any ordinary stream. If it is desired to have a thoroughly clear effluent, there is no difficulty in taking that suspended matter out by an ordinary sand filter, worked in the same way as an ordinary water filter. The material taken out will readily dry, is non-putrescible, and can be spaded off the sand at a very small expense, and it does away, practically, with the smell altogether. The same result can be obtained by sedimentation without filtration or by land treatment.

Mr. A. CREER: I think the experiments carried out by the London County Council have been instrumental in bringing to bear upon this subject a great deal of thought by Members of this Association, and I think that to gentlemen who devote nearly the whole of their time to the subject we must look to some extent for light and leading. During the last three years I have been experimenting with filters of one kind or another. Notwithstanding that we had only recently completed a big scheme of chemical precipitation, that was found fault with by the Local Government Board and by the authority that had jurisdiction over the river into which the effluent flowed. First of all we put down an ordinary septic tank with filter beds. These were not so satisfactory as we might have wished. I then tried contact beds, and I must say my experience of contact beds was that they were very satisfactory. The only objection I had was that for the area covered you could only get such a small number of gallons per 24 hours through them. I then tried the continuous filter, with a radiating distributor, and that has been at work three years, giving excellent results. With regard to the point raised by Mr. Silcock, as to the disintegration of the material, that is a most important matter. About twelve or fifteen months ago, when the filter was off for the construction

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of a grit tank, I took the opportunity of opening down to the material forming one-half of the bed. I found the material quite clean and sweet. It was common clinker obtained in the neighbourhood. I turned all the material in one-half of the filter over, and at the bottom found there was an accumulation of about 6 inches of fine black ash, which had set so hard that no matter what quantity of water had been turned into the filter, it would have been impossible to wash it away. After I had removed this fine ash, I made up this side with the old material and sufficient new to make up the deficiency, and re-started the filter. For some time after re-starting, the side of the filter that had been restored gave very much better results than the old part of the filter. There was not so large a proportion of suspended matter, and the effluent gave better results, both in oxygen absorbed and albuminoid ammonia; but in six months' time there was no difference between the two sides of the filter. The results week by week showed there was no difference, but that the old part of the filter was just as good as the new. With reference to the best filtering material, I have had an experiment in hand, but I am sorry it has only been at work for such a short time that I cannot give any definite results. The filter is 100 feet diameter, made of ordinary pigeon-hole brickwork filled-in in sections. The larger section is of clinker; another section filled in with ordinary gas coke; a third section with broken bricks; and a fourth section with what is called in the north honeycomb slag. It is very porous, very hard, and gives no signs of disintegration. I have had it lying in water for two years without it giving any sign of disintegration. I have had these working for about a month. The conditions are identical; the same depth; the same quality of sewage; and I hope at a later date to give the Association information in connection with it. I am afraid this system of bacteriological treatment of sewage is not going altogether to solve the difficulty. It is going to reduce the quantity of sludge enormously, but at the same time I believe the remaining sludge, that is, the sludge from the open septic tank, is going to be very difficult to treat or press on the lines we have been accustomed to press sewage sludge.

Mr. J. D. WATSON: In considering this paper we should not forget that London is in a peculiar position. The effluent is discharged into a very large river, and it may not be necessary to

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produce an effluent as good as would be required in various parts of the country. Nothing is said as to whether the London sewage is particularly strong, or whether it is of a moderately weak character, but even if it is very weak I am rather surprised to find the statement that the treatment employed produces an effluent which by chemical examination is found to be practically non-putrefactive, and able to sustain fish life. I am rather surprised at this, because I have under my charge about four acres of beds constructed very much like the beds described here by Dr. Clowes; they are also filled for the most part with coke, and I find that the result of treating raw sewage on those beds is something like 50 per cent. of purification on raw sewage. By being more careful of the quality of the sewage put on those beds and by using them as contact beds for the ordinary alternating periods, we can obtain something like 60 per cent. of purification, but that 60 per cent. does not yield a non-putrefactive effluent. It may yield an effluent which is good enough for a tidal river, like the Thames at Barking or Crossness, but it would not be good enough for a sewage filtrate passing into a stream like the river Tame, or any other small river far removed from the sea. Professor Robinson has called attention to the fact that the two London experts, Dr. Clowes and Dr. Houston, are not altogether at one as to what should be done, as to whether or no the effluent is sufficiently good to be discharged into the Thames, but I hope that before they get to work the experts will see eye to eye in this matter. With regard to the material recommended in the paper, namely coke, I may say I have had some difficulty with hard coke. One of the difficulties is that it floats in water, and when the sewage is let into the bed I sometimes find it lifts the coke at one part of the inlet sill, and brings it round to another part of the sill; special provision has to be made for retaining the coke in the bed. Notwithstanding the provision made, I have to say that tons of coke have been washed away. I merely mention that as a warning to those who are thinking of using coke on a large scale. Then I have found that coke resolves in water, and that is distinctly undesirable. You ought to have, in my opinion, a material for bacteria beds—whether the contact bed or the percolating bed—which will not resolve in water. I have tried various materials, amongst others slag, and I am not altogether sanguine about obtaining very fine results

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from slag. It contains too much lime and too much magnesia. But I do not wish to say very much upon that subject, until the tests which are being made have been continued for a longer time. I have tried clinker, and found that, like coke, it is apt to resolve in water. We are obliged to use different kinds of material for different works, there is not that homogeneity that one would like on comparing one result with another. You have to submit to constantly varying conditions. I think it will be found that we shall all be obliged to use the material at our hands more or less. In one district gravel, in another stone, in another coal, in another clinker; in another we may obtain a hard broken brick. I believe that to be a very good material. My Board have just accepted tenders for percolating beds of four acres, filled with broken Staffordshire bricks. I think that will form a good material, but it is not so cheap as some others. I saw a very excellent bed at Hanley made of broken saggers. That material is about the finest that can be obtained, but it is a material which can only be found in a very small quantity.

Communicated Reply.

Dr. Clowes: (1) There is no variance of opinion between the chemist and bacteriologist in the third report issued by the London County Council. Chemically the bacterial effluent shows a great improvement upon the sewage; it is not putrescible when incubated at 80° F., its rapidly changeable organic matters have been removed, and it is in a condition of aëration sufficient to support the life of fish. The bacteriologist states that *bacterially* he found the effluent not appreciably better than the sewage, a statement which is entirely compatible with that made by the chemist, and he goes on to praise the bacterial process. (2) The contact method of treatment has been tried in the County Council experiments in competition with the "so-called" sprinkling method, and was approved because it gave a purer effluent and dealt with a larger volume of sewage in the same time. (3) The purification by bacteria occurs at the surface of each fragment of coke or other material, and not *at the surface of the bed only*. A deep bed, therefore, has the advantage of dealing with a larger volume of sewage than a shallow one covering the same area, the volume dealt with being proportional to the depth. (4) Hard coke has been found to serve for many

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years in the bacteria beds without undergoing disintegration; but coke of an unsuitable kind undoubtedly suffers in this way. Harder materials, such as clinker and furnace slag, were somewhat inferior to coke in purifying power. The coke had never given trouble by floating away if reasonable processes of filling are used. (5) The evidence that the contact beds did not lose in capacity permanently had been published in the London County Council's reports, many of which were now out of print; it would be republished in the book about to be issued by the Council. The paper read before the Association pretended only to be a summary of results obtained. (6) A properly managed septic tank does not give rise to nuisance, and it presents great advantage in averaging the quality of effluent to the contact-beds, and in delivering a suitable effluent.

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THE SCOTT-MONCRIEFF SYSTEM OF SEWAGE TREATMENT.

By W. D. SCOTT-MONCRIEFF.

When asked by your President to read a paper on the "Scott-Moncrieff System of Sewage Treatment," it was with great pleasure that the Author acceded to his request, but at the same time it was with considerable diffidence that the Author accepted the title which was suggested to him. In a purely natural process, there are only two lines upon which original research can move—the one being an investigation of the facts, and the other a development of means for applying them. Where the discovery is novel, the facts few, and the means of utilising them comparatively simple, the labours of one man may be associated with them, and the system or method may be called by his name. When, however, his discoveries involve the invocation of natural forces that require the labour of many lifetimes to elucidate, he would be a bold man indeed who could speak of his process or system in such a connection. It is a sufficient source of satisfaction to the Author to know that the first report upon his early experiments is the first literature on the subject of the bacterial treatment of sewage upon the lines that are now generally accepted as final. Müller had anticipated the Author in the suggestion of utilising what he spoke of as "yeast-like organisms" for the purification of sewage, and Mouras had developed what is now spoken of as hydrolysis in a resolving tank or chamber, but neither of them had looked upon this process as only preliminary to nitrification under wholly different conditions. On the other hand, Warrington and the Massachusetts Board of Health had both overlooked the importance of the anaerobic fermentation as an

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almost essential factor in the natural sequence of mineralisation, while Adeney did not suggest that the process of nitrification could be carried out unaided by chemicals of any kind. The name of the Author may possibly be associated with this sequence of anaerobic followed by aerobic fermentation, but even if he were to lay claim to such a discovery, his individual labours are trifling compared with the work of others who have made innumerable contributions to the subject in many different directions.

One peculiarity of the sewage problem has been that its solution has been a pressing need of modern civilisation, and the scale upon which it has to be carried out has made the discoveries of the laboratory comparatively unimportant unless means could be devised for applying them to vast volumes of sewage. The consequence of this has been that millions of money have been spent upon schemes that were defective in principle at the outset because there was no available knowledge as to how the theory and practice of bacterially treated sewage could be successfully combined so as to cope with the cases of great urban or even of small village communities. Speaking for himself, the Author can only say that years passed between his first experiments and the time when he at last began to grasp the main features of the problem, and even when he had done so, and was able to establish his position by absolute proofs, the mechanical difficulties that confronted him appeared almost insuperable. What the Author thinks he has some good reason to complain of is that for several years he has been arguing the necessity for more scientific methods, and that he has had neither support nor encouragement of any kind, while all the time great sums of money are being spent upon professional advice which is often worse than valueless.

This paper must be a short one, and as you are an association of practical men who are largely responsible for spending the money of the ratepayers, you will no doubt wish to be given some practical counsel and advice. The Author will, therefore, say a very few words first about detritus chambers and anaerobic fermentation, and then speak more fully upon nitrifying or oxidising filters.

The most successful detritus tank known of by the Author

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was not designed as a detritus chamber at all, but as a tank for the deposition of sludge from chemically-treated sewage. By ceasing to use chemicals of any kind it became a detritus chamber, in which, on account of its great dimensions, anaerobic fermentation went on naturally before the sewage passed to the resolving tanks, which were also designed for chemically-treated sewage. The hydrolysis in this case is so complete that at the end of two years there has been practically no deposit in the resolving tanks of any kind. Upon putting down a pole it strikes hard upon the bottom of the tanks. As the Author had no hand in the designing of these tanks it is hardly for him to give you information as to the details of their construction or the method of using them. They are to be seen at the Birmingham sewage works, and no doubt the engineer, Mr. Watson, will be pleased to give you all particulars. Putting this case on one side, it appears that there is ample information now available for the construction and management of resolving tanks, and that this part of the bacterial process is now removed from the debatable region of experiment. The Author does not even venture upon giving you advice upon this branch of the subject. He may say a word, however, upon the first form of tank which he used for the purposes of experiments in anaerobic fermentation, which the Author constructed, and called a "Cultivation Tank." The most absurd travesties of this apparatus have been experimented on, and papers have been read upon them to show how they have failed. The Author need hardly say he is in no way responsible for results which have been the natural consequence of the apparatus being badly designed.

The Author is afraid you will not think very highly of such scant advice about detritus chambers and resolving tanks, but his reticence is really a compliment to what has already been accomplished in this direction, and what will now be the most satisfactory course for all of you to follow is to compare your various experiences, and to be keenly alive to every kind of criticism in matters both of theory and practice so long as it is based upon reliable data.

Coming now to the question of aerobic filtration, the Author finds himself upon different ground. The oxidising of organic nitrogen in solution into inorganic nitrogen is a more difficult process than the changes which are produced by anaerobic

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fermentation in a tank. One of the first questions that occurs before discussing the details of the filters is, What is the standard of purity required in the effluent? Probably you already know the Author's opinions on the subject of effluents. The Author maintains that, wherever the percentage of oxidised to unoxidised nitrogen in an effluent is as high as the water of the Thames above the intake of the water companies you are safe in ignoring all other conditions, and that where such a ratio exists other substances, such as ammonia and albumenoid ammonia may be safely disregarded, because when the ratio referred to is sufficiently high they will be rapidly oxidised by the available oxygen in the effluent.

The Author thinks every one will agree with him, that the designing of sewage purification works at the present time makes great, in fact, quite unusual and excessive demands upon the intelligence of the engineers who are responsible for the results obtained from them. In other departments it is generally sufficient for the engineer to refer to his tables and text-books, but as neither of these are at present available for the successful designing of bacterial purification works the construction of them necessarily requires a considerable element of invention and discovery. This would be of little importance if the necessary data were available, but, as matters stand, the state of knowledge can quite aptly be compared to that of a mis-named expert who is called upon to design an electrical installation when he is ignorant of the difference between a volt and an ampere; or we might go still farther, and compare it to the case of a man who was called upon to construct an electrical installation before electrical science was provided with accurate data of any kind.

The knowledge which is absolutely necessary in order to the successful design of bacterial plant for the purification of any particular sewage is as follows:—

1st. It is necessary to know the best period during which the anaerobic or putrefactive fermentation should be carried on. It is upon this information alone that the proper dimensions of the tanks for any particular sewage can be stated with confidence, and ignorance of this important factor makes the dimensions of the tanks a mere question of guesswork.

2nd. The necessary quantity of air must be known, which is necessary when favourable bacterial conditions are present, in

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order to oxidise the organic matter, or in other words, to take full advantage of the life processes of the organisms which are available.

3rd. When the proper period of anaerobic fermentation and the proper quantity of air have been ascertained, it is necessary to know the proper depth of filter, because, as in the case of the resolving tanks so in that of the filters, ignorance is productive of nothing but speculation. It may often happen that twice the necessary amount of filtration may be provided for because of an insufficient air supply, or in other words, that half the capacity may be sufficient when the optimum air supply is available.

4th. The optimum quantity of liquid for each discharge must be ascertained.

5th. The proper period of rest between each discharge, in order to prevent the deterioration of the filters by gelatinous growths, must be found by actual experiment.

The Author thinks he is safe in saying that it is doubtful, even if all your experiences are combined in one person, with the expert knowledge of the Royal Commission and their officers and the originality and enterprise of the Local Government Board thrown in as well, he could honestly say that—before he makes recommendations, or even before he undertakes the easy task of criticism—he first protects himself by ascertaining these absolutely necessary conditions.

It will be the object of this paper to show how a knowledge of these factors can be ascertained. The necessity of having data available for any particular sewage before commencing to design a bacterial plant is obvious, but the Author will refer more especially to the air factor, as one that has been almost wholly disregarded and left more or less to the chapter of accidents.

To nitrify 5 parts per 100,000 of organic nitrogen in an effluent (1 gramme in 20 litres) about half its volume of air is used up in the process. This is the quantity required for supplying the necessary oxygen to produce the reaction, but it by no means represents the quantity that must be passed through the filters, because carbonic acid gas is present in large quantities, and must be either removed or largely diluted with air to provide favourable conditions for the work of the organisms. Now no one has hitherto attempted to find out the actual quantity

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of air necessary in any given conditions for producing any required standard of purification. The Author does not think, therefore, that he was far wrong in comparing this to the case of a man designing an electrical installation before the existence of electrical measurements.

The same remarks apply in a somewhat modified degree to the other factors in the problem of nitrification, because, although experiment on an existing filter may prove what is the best rate of discharge for producing a required effluent, the information is obtained in ignorance of the optimum air supply, a knowledge of which might greatly modify the other factors, including also the factor of rest and the required depth of filter as well.

The Author wishes to impress upon you that if Nature demands that a certain condition must be complied with in order to obtain some desired result, nothing can be gained by any shirking of it. Nature will wholly disregard your attitude until you comply with her conditions, but when you do so, you will find her your very humble servant. This element of air is an essential condition in order to obtain nitrification, and it is as reasonable to expect to draw water in a bucket without a bottom as to get bacterial purification without oxygen. The extraordinary thing is that no one has taken the trouble to find out how much air is necessary in terms of a measurement of any kind except in the laboratory under totally different conditions.

Possibly some of you may have heard of the Author's experiments at Ashtead, which were published in 1898. In that investigation the factors of depth of filter, rate of discharge, and periods of rest between each discharge were accurately measured and samples drawn at different depths, but the results obtained were only relative to the actual conditions which consisted of small trays superimposed one upon another with air spaces between. The air supply required to produce percentages of nitrification which rose as high as 98·6 per cent. of oxidised to unoxidised could not be measured, and the super-imposed filters were not applicable on a large scale which would in any case have altered the conditions. It became necessary, therefore, to devise some method by which the air as well as all the other factors, could be measured.

Before describing the apparatus the Author would point out that the fact of its being only a section of a filter-bed does not

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militate against its usefulness as an accurate means for obtaining data upon which to construct a large installation so long as the sewage to be treated in both cases remains the same. In order to measure a mile it is not necessary to have a rule 1760 yards long. If the information obtained from an actual section of an intended or existing filter-bed is accurate it does not matter what the dimensions of the section may be, because, if the same conditions are maintained, the section may be multiplied indefinitely with exactly similar qualitative results.

You will see from the diagram that the apparatus represents the section of a filter-bed six feet in depth.

It might be argued, that although the apparatus is a real section of a filter-bed, the arrangement for distributing the sewage is so small that it could not be applied upon a large scale simply by increasing its dimensions. It is right, therefore, that the Author should explain that it is not proposed to make use of the same arrangement for distribution on a large scale. All that is required is, that the distribution should have an equivalent accuracy to that which can be produced by existing machines that are capable of dealing with great volumes of sewage. But, although this is in fact realised by the apparatus, it is obvious that, for the purposes of comparing one sewage with another, it is only necessary that every standardising appliance should act in an exactly similar way. What is further required in the testing apparatus is that it should be capable of being easily adjusted, so that great variations of flow and of the periods between each discharge can be easily obtained by it. You will see that by adjusting the fulcra of the tipping-tray, and the distance to which it falls, the two factors of the quantity of each discharge and the rest between each discharge can be varied almost indefinitely. Now, it is quite obvious that these two factors of discharge and rest for any required standard of purification must vary with the air supply and the depth of filter. In the case of an insufficient air supply the quantity of liquid dealt with must be cut down to meet it, or, in other words, the efficiency of any given filter must be correspondingly reduced. It is obvious, at the same time, that the most important element from a money point of view is the minimum of filtering capacity, because the tanks and filtering material, including the necessary apparatus, are the principal items of cost. We thus find that all the factors that make for

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economy, viz. maximum of discharge and minimum of filtration depth, are dependent upon the air factor, while the bacterial efficiency of the filter-bed depends upon the quantity and the periods of the discharge being properly adjusted in order to maintain the results obtained from the optimum air supply.

The Author will now deal with the case of an engineer who is called upon to design nitrifying filters for a particular sewage. In order to find out the necessary data, he passes the sewage through the testing apparatus, say, to begin with, at the rate of 500,000 gallons per acre per twenty-four hours, or about 4 pints per foot per hour, which we know from experience on a large scale is a very moderate computation. This rate of flow is obtained by adjusting the valve controlling the supply. The next step is to discover what is the best quantity to deliver at each discharge, or in other words, how the total discharge should be divided so as to give the best results. This is done by adjusting the tilting apparatus, and the corresponding adjustment on a large scale would be obtained by increasing or decreasing the number of times per hour the distributing machine passed over the filter. We will now suppose the apparatus is adjusted to discharge every four minutes—this would give about one half-pint per foot for each discharge, still giving the rate of 500,000 gallons per acre per twenty-four hours. Having made these adjustments, the aspirating apparatus is set to work with an air supply, say, at the rate of 4 cubic feet every ten minutes, or 8 cubic feet per square foot of filter surface per hour. The filter being in full bacterial activity, these conditions of discharge and rest and air supply are maintained for twenty-four hours, and samples are drawn from different depths of the filters to discover which of them gives the required standard of purification. Supposing this is found at the fourth tap, that is to say, at a filter depth of 4 feet, the rate of discharge is increased, and samples drawn next day to find how the increase has modified the results. If it is found that the additional depth required has been increased to the fifth foot of filter depth for, say, a discharge at the rate of 750,000 instead of 500,000 gallons per twenty-four hours, the air supply can then be increased, or the factor of rest varied, and samples taken in twenty-four hours to discover if any economy can be effected by these alterations on the depth of filter necessary to produce the required standard of purification. Referring to Tables I. and II., provision is made

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for recording the necessary data, and after experiments extending over a few days, a table can be filled up which will be the standardised quality of the sewage in terms of columns A, B, C and D, and it can be described, for example, as A 5, B 3, C 8, D 6. The necessary plant can then be designed throughout with an absolute certainty of results corresponding to those obtained from the apparatus.

It is almost unnecessary to point out that similar information can be obtained with regard to storm-water sewage, so that if a lower standard of purification is allowed for a storm the maximum rate of flow through the filters can be accurately known beforehand. The apparatus will also be of service in settling disputes about the effects of trade refuse, as the differences between two samples, one above and the other below the point of discharge of a manufactory, can be accurately compared. If the former, for instance, came out at the figures given—A 5, B 3, C 8, D 5—and the sample below at A 3, B 5, C 12, D 6, the difference must speak for itself. In the same way the value of different kinds of filtering material can be accurately ascertained, and the bacteriology investigated, at every stage of the process as well.

DISCUSSION.

Mr. J. D. WATSON: I have pleasure in moving a hearty vote of thanks to the Author of this paper. We are told that at Manchester they are able to purify efficiently, and to produce a non-putrefactive effluent with little more than one contact after the sewage has been treated in open septic tanks, but we do not all understand that the sewage, as it comes to the Manchester works, is, from the Birmingham point of view, a very mild sewage. The average oxygen absorbed in four hours is equal to 9 parts per 100,000. The sewage I have to deal with has an absorption of 18 to 19 parts per 100,000. We cannot be expected to get as good an effluent as Manchester, and certainly it cannot be done at the same cost. While I agree with Mr. Scott-Moncrieff in the main, I do not agree with him when he says that a sewage which requires a greater depth than 6 feet of oxidising medium is past praying for. I think the better way would be to have more than one bed; it may occasionally be

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I. *Parts per* 100,000.

Total organic nitrogen.	Total inorganic nitrogen.	Total nitrogen of all kinds.	Dissolved oxygen.	Matter in suspension.	REMARKS.

II. *Parts per* 100,000.

6	7	8	9	REMARKS.
				Effluent
				Percentage purification
				Feet of filter
				Nitric Nitrogen Nitrous nitrogen
				Total nitrogen oxidised
				Total nitrogen
				A B C D

[*To face p.* 288.

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found that to have two beds of medium depth which would admit air freely, would be better and more economical than one of great depth, into the heart of which air does not readily penetrate.

The PRESIDENT: I think I am only voicing the views of the Members present in heartily seconding the vote of thanks to Mr. Scott-Moncrieff for the able paper which he has prepared and placed before us. If there are any data or series of instruments to bring about the saving of the ratepayers' money, it would be a very great advantage indeed to the overtaxed community.

Mr. SCOTT-MONCRIEFF: I thank the Association very much indeed for their kind vote of thanks for this paper. I may say that the system with which I would wish my name to be associated, and which would include the features I have been advocating for many years, must provide the following conditions, every one of which is necessary to complete success.

1. Providing that amount of anaerobic fermentation which is required for the breaking up of the organic matter in unstable compounds capable of being fully oxidised to nitrates by the action of aerobic organisms.

2. Means by which the zonal changes which take place in downward filtration should be carried on regularly and without any serious alterations in the environment at any stages of the process, such as occur in the "contact" system.

3. Means by which the aerobic organisms are supplied with no more than the maximum amount of nutriment at one meal that they are capable of digesting.

4. Means by which a time of rest between each meal is secured so as to avoid the development of gelatinous growths in the filter bed.

5. Means by which the organisms are provided with an air supply proportional to the amount of nitrification demanded by different kinds of sewage.

I think I may claim that this is my system in so far that I am even now the only person who has recognised and advocated that the five foregoing factors are the necessary and only conditions demanded by Nature in order to obtain complete and final success. It is needless to say that the testing apparatus is to establish these factors in exact terms before spending money upon works or alterations.

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Communicated Discussion.

Mr. Sidney R. Lowcock: I cordially support Mr. Scott-Moncrieff in his endeavour to place the design and construction of bacterial filters on a scientific basis, and to ascertain among other data the proper amount of aëration to be provided for any particular sewage or class of sewage. As far back as 1892, I endeavoured to ascertain the quantity of air required in the bacterial filtration of domestic sewage to give the best results, and particulars of this are given in the paper I contributed to the Institution of Civil Engineers (vol. cxv.), but from that time until the present experiments of Mr. Scott-Moncrieff, so far as I know, very little has been done in this direction. The whole matter appears to be in a somewhat chaotic state, and the terms "bacteria beds," "contact beds," "bacterial filters," and "trickling" or "streaming filters," are used to a considerable extent indiscriminately. It appears to me that the Association might very well definitely classify the three systems now used, that in use at Sutton and other places being known as "bacterial contact beds," or simply "contact beds," while the other systems in which the liquid is distributed over the surface either intermittently or continuously and allowed to trickle downwards through the filter, the outlet from which is always open to the air, should be known as "intermittent bacterial filters," and "continuous bacterial filters," respectively. My experience leads me to entirely endorse Mr. Scott-Moncrieff's contention that the final purification of any sewage effluent must be effected by intermittent bacterial filters, such filters being either artificial, that is specially constructed, or natural, that is land, where it can be obtained of a suitable quality and price—unfortunately these conditions are very rare. At one time I thought that continuous working was possible, but I have long since found that we must in this as in other details endeavour to follow nature as closely as possible, and that the operation of the filters must be intermittent. The only difficulty with artificial filters is now the distribution of the liquid over the surface. Distributing troughs, however elaborate, are unsatisfactory. For small installations tippers or other means for flushing small quantities intermittently on to the surface work very well, but are not suitable for large areas. For these the only satisfactory

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arrangement is some form of sprinkler which will apply the liquid intermittently in as nearly as possible the form of rain. This means in most cases the use of mechanical power, which is unpopular in connection with sewage treatment, but which I am convinced will have to be adopted. In 1900, I was instructed by the Worcestershire County Council to prepare, in consultation with Dr. G. H. Fosbroke, the medical officer of health for the county, designs and specifications for the construction of three separate systems of bacterial sewage treatment for the assistance of any persons in the county wishing to make a trial of such methods, and the County Council subsequently had constructed two complete sets of experimental works from these designs, so as to compare the efficiency of each of the three systems when dealing with, in the one case domestic sewage only, and in the other, town sewage containing considerable quantities of manufacturing and chemical wastes. I have just received a report of the results of twelve months' working of the set dealing with domestic sewage only, some details of which I hope may prove interesting to the Members. The three systems, which are placed side by side, are: (i) covered anaerobic liquefying tank followed by intermittent bacterial filters; (ii) rough contact beds followed by intermittent bacterial filters; (iii) upward flow anaerobic filter followed by intermittent bacterial filters. The sewage is taken from the main outfall sewer and passes in each system first through a mixing channel and a small detritus chamber, and in each case the effluent from the preliminary treatment is well aërated before passing on to the final intermittent filters. A very important feature in these experiments is that the sewage is taken from the outfall sewer through V-shaped notches, the apex of each being on a level with the bottom of the sewer, and the proportions of the notches are such that the flow of sewage to each system is proportionate at all times to the flow in the main sewer, so that the systems were working under really practical conditions both as to quantity and quality of sewage dealt with, and not taking a small regular quantity only as is so often the case in experiments. The total quantity of dry weather flow dealt with by each system was 1000 gallons per day of 24 hours, but in wet weather this quantity was, of course, largely exceeded. The intermittent bacterial filters were in each system divided into four, and were filled respectively with coke, coal, broken brick,

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and granite, and the effluents from each were separately analysed. The averages of all the analyses for twelve months show that system (i), with coke filter, is the most satisfactory, reducing the oxygen absorbed in four hours at 60° to 1·11 parts per 100,000 (a reduction of 82 per cent.), and the organic nitrogen to 0·2 parts (a reduction of 94 per cent.). System (ii) reduced the oxygen absorbed 73 per cent., and the organic nitrogen 86 per cent. System (iii) reduced the oxygen absorbed 72 per cent., and the organic nitrogen 85 per cent. System (i) produced no nuisance whatever, and in the mixed effluents from the three systems gold fish lived for over a month without any apparent ill effect. It must be borne in mind that these results were obtained when treating *domestic* sewage only; probably the results of this kind of bacterial treatment will also be satisfactory when applied to the sewage of towns containing a small or moderate proportion of manufacturing waste, but with sewages containing chemical waste the indications are that it will not be satisfactory, and chemical treatment of the sewage before putting the tank effluent on to the intermittent bacterial filters will probably be necessary. In the cases of large towns and cities also I believe it will be found cheaper and more satisfactory to treat the sewage in a similar way, and I think Professor Clowes is wise in retaining the chemical treatment of the London sewage.

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TREES IN PUBLIC ROADS.

By FRANCIS SMYTHE, Engineer and Surveyor to the Urban District Council of Finchley.

The planting of trees in streets and public places is now receiving the attention of local authorities it deserves, and has during late years made such progress that the up-to-date municipal engineer must necessarily add arboriculture to the many subjects of which he must make himself proficient, and it was, therefore, with great pleasure the Author accepted the mandate of our respected President to read a paper at this meeting. As the Author has already read a paper upon the subject at a meeting of the Association at West Bromwich in 1893, he must necessarily repeat some of the matter contained in that paper.

Local authorities naturally do not care to vote the expenditure of public money upon pure æsthetics, but they are beginning to be alive to the fact that trees in public roads not only tend to increase the attractiveness, and, therefore, assessment of a district, but also materially affect the health of its inhabitants, especially in towns, and it is the latter fact the Author wishes municipal engineers to impress upon their councils when they have the matter under consideration.

Trees have a greater effect upon the health of human beings than most people have any idea. Although the inhabitants of a well governed town live under much superior sanitary conditions than those generally in rural districts, the normal death-rate of towns, as a rule, rises in proportion to the density of its population, and generally exceeds that of the country districts, carbonic acid gas being one of the elements which contribute to the cause. While in the air of rural districts there is but a trace, in some large towns it exists to the extent of as much as ·050 per cent. The Author need hardly point out this gas, even in the smallest quantity, is inimical to human life, and every means

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adopted with a view to its elimination from the atmosphere, must have the effect of increasing the health of a population. Carbon combined with water forms the greatest proportion of the constituents of plant life, and as carbon can only be assimilated by plants in a soluble form, carbonic acid gas is absorbed by them in considerable quantities, not only by means of their roots, but to a much greater extent by the pores of their leaves. In the process of assimilation, the carbonic acid gas is decomposed by the action of light, the carbon is retained, and oxygen, which is conducive to health, is thrown off. Although at night a reverse action takes place, the leaves excluding the carbonic acid gas absorbed by the roots, the amount of gas thrown off at night has but a very small ratio to the amount of oxygen excluded during daytime.

Another constituent absorbed by trees is ammonia, which is much more prevalent in populated places, especially manufacturing districts, than in the country, due to the decay of a greater amount of organic substances in a confined area. When the enormous area of leaf surface of a single full-grown tree is considered, it can be better understood what effect the process described has upon the atmosphere. The laws relating to plant life are identical with those to which animal life is subject. A tree growing with the population of a town will thrive when that town is densely populated, whereas it would be difficult to get a sapling to grow in a town already with a large population; it is therefore advisable that planting trees in roads should be done simultaneously with the development of a district.

The assimilation of food by, and the life of a plant, are almost identical with that of an animal; the same circulation takes place, the roots act as the stomach, and the leaves the lungs or respiratory organs, with the difference, that the latter also absorb a considerable amount of food in addition to the roots in the form of moisture, and more especially carbonic acid gas. The plant must not have an excess of moisture or plant food, especially of a nitrogenous or stimulating character, in its young state, beyond its capabilities of absorption and assimilation, as in animal life, otherwise the same effect takes place, and the plant becomes sickly and debilitated. The weak sickly plant, as in an animal, is always more liable to be a prey to diseases than a healthy one.

The process of assimilation of food by a plant is as follows.

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At the end of every fibre of a root are what are termed spongioles, or spongy formations, which absorb the necessary food in a liquid or soluble form; from these, ducts or tubes along the roots convey the liquid food to the plant. During its course chemical changes take place in the food, and what is known as "sap" is being formed. By capillary attraction, aided by heat, light and other means, the sap ascends the trunk through similar channels, the larger sized and greater number being in the alburnum, or outer layer of wood, passes along veins on the upper surface of the leaves, and then descends by another form of channels along the under side of the leaves, and down the inner surface of the bark. During its course the sap is gradually building up the tissues of the tree, and also feeds buds that are being formed; it is the intermittent flow of sap in summer, and its nearly quiescent state in winter, that forms the rings seen in the section of a trunk of a tree. The remaining sap returns to the roots and spongioles, where it forms the basis of the chemical transformation of the food absorbed. Nature has also provided the leaves of a plant with a large number of minute pores or cells, which practically act as lungs; but during such times that the tree through its spongioles is unable to obtain enough nourishment, they absorb a proportionate quantity of plant food, hence it is that trees and plants are kept from failing during long droughts by the large quantity of moisture absorbed by their leaves.

If the roots or any branches of a plant are broken, a hard film, commonly called a "callus," is formed upon the surface of the wound, the sap is arrested in its flow as soon as the callus is formed, and the former finds fresh outlets at the weakest points of the roots or branches; and it is on account of this that the growth of a tree can be improved, first by frequent transplantation, and afterwards by judicious pruning, since the former increases the number of rootlets, and the consequent spongioles, and the latter the number of branches, and resultant leaf or lung surface. It is for this reason that a plant which has been allowed to grow a considerable time without transplanting, has a single large long root, called a tap root, having only perhaps one or a small number of spongioles at the end, whereas a transplanted plant has a considerable number of rootlets, with a spongiole at the end of each. For the same reason the plant with a tap root takes a longer time to overcome the effects of

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transplanting. The leaves and roots of a plant act in unison; if deficient of root growth when planted, it will never do much good until sufficient roots for the proper development have been formed, so that it is important that a young plant has a good bole of roots before being planted. At the same time a tree, especially in the younger stages, may have its leaf area much extended by judicious pruning, and a consequent increased activity of root growth.

Again, if pruning is done, a certain amount of retardation of the flow of sap takes place in proportion to the amount of pruning, especially to the main stem or direct artery of the tree; quicker crystallisation of the sap in consequence of the retarded flow follows, and the thickness of the trunk increases more rapidly.

Selection.

Before deciding what trees to plant, the Author advises that a close inspection be made of all existing trees in the neighbourhood, and those in a flourishing state suited for road work be noted, and planted. The next thing is to see that the saplings to be planted have each a good bole of fibrous root, rejecting those that have only a tap, or stalky looking root with little or no fibre. It is best, if possible, to obtain them from a nursery where they are grown in the immediate neighbourhood, as then they can be taken up and planted at once with very little check. When they have to be brought from a distance a considerable time has to elapse before they can be planted, and during this time the roots, more especially if they be fine fibrous ones, get dried up by cold winds, and it takes a much longer period of recovery after they are planted.

The Author would prefer, if he had a small piece of ground available, to purchase saplings say 4 or 5 feet in height, and plant them in nursery beds, which, however, must be first well dug and cleaned, and afterwards kept hoed to eradicate weeds. These should be planted in rows say 2 feet apart in the rows, and 3 feet between the rows. In two years' time these should be taken up and replanted, in order, as before described, to have a good bole of root, in rows 5 or 6 feet apart and 3 or 4 feet between the plants; in another two years they would make good sized trees, fit to plant on the roads. Saplings as described may be purchased for say, maple or sycamore, 10*s.* per hundred,

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and planes or oak, 20*s.* per hundred delivered, to which must be added the cost of digging and planting, approximately another 10*s.* per hundred, whereas if purchased large enough to plant direct they will cost from 2*s.* 6*d.* to 5*s.* each.

The Author suggests the following trees as being suitable for road planting, with the soils most congenial to their growth; they are also given somewhat in the order of preference, this is, however, subject to the circumstance of locality, position, etc.; the first, the plane, being undoubtedly the finest tree for road planting where the subsoil and other conditions are suited to its growth.

Plane (*Platanus occidentalis*), London	Heavy soil.
„ (*P. acerifolia*)	„
Maple (*Acer platanoides*), Norway	Any soil.
Sycamore (*O. pseudo-platanus*)	„
Oak (*Quercus*), Turkey	„
„ „ English	Heavy soil.
Poplar (*Populus*), Canadian	Any soil.
„ „ Ontario	„
„ „ balsam	Heavy soil.
„ „ black Italian	Any soil.
„ „ Lombardy	„
Elm (*Ulmus*), Camperdown	Heavy soil.
„ „ Scotch or Wych	„
Lime (*Tilia europea*), European	Light soil.
„ (*T. dasystilla*), Crimean	„
„ (*Tilia*), red twigged	„
Birch (*Betula*), common	Any soil.
„ „ silver	„
Ash (*Fraxinus excelsior*), common	„
Willow (*Salix fragilis*)	Moist soil.
„ (*Salix*), Huntingdon	„
„ (*S. alba*), white	„

There are also several handsome flowering or berried trees most suitable, so far as growth is concerned, for planting on roads, but their flowers and berries are fatal to their use, on account of the havoc done to the foliage by children trying to obtain the flowers and berries. Apart from the nature of subsoil, the character of the locality has to be taken into account. There are also some trees that will not thrive on a chalky subsoil.

Trees for Manufacturing or Smoky Districts.

Planes, Norway maple, sycamore, poplars, ash.

Trees for Cold Exposed Positions.

All the trees mentioned except planes and limes.

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Trees for Seaside.

Sycamore, Norway maple, Turkey oak, Camperdown elm, grey poplar, white willow, common ash.

Trees for Chalk Soils.

Norway maples, sycamore, poplars, birch, ash.

CHARACTERISTICS OF TREES.

Planes.—Are, *par excellence*, the tree for planting in streets, especially in towns, provided the situation is not an exposed one, and the subsoil is clay or marl. For cold districts *acerifolia* is to be preferred, as it is somewhat hardier than *occidentalis*. Planes have the advantage of having clean stems for a considerable height before the lateral shoots are thrown out. On account of having the peculiarity of annually shedding its bark it is particularly adapted for towns; the surface of the leaves being hard and glossy soot and dirt are soon washed off them by the rain.

Maples.—For all-round planting there is no better tree than that of the acer tribe; they will thrive in places where many other trees would not grow, as they are one of the hardiest of trees, not particular to situation or soil, and may be planted anywhere. Preference should be given to the Norway maple, as the leaf is finer, and the surface of the leaf harder than the sycamore, the leaves of which have a tendency to collect soot and dirt, and also get a rusty appearance in droughts.

Oaks.—Unfortunately the English oak is a slow grower, and also needs a heavy soil to do well, but the Author particularly recommends the planting of the Turkey oak; it makes rapid growth, even in poor soil, will do well by the seaside, is very hardy, and when in full growth a very handsome tree.

Poplar.—All the *populus* tribe are suitable for roads; will, like the acers, thrive where other trees will not live; will do well in the most exposed situation, and in any soil. Most of them, however, have one fault—viz. they throw out very heavy lateral branches, which, if not annually hand pruned during the younger period of growth, break off close to the trunk during high winds, when the tree has attained full growth. The pruning causes considerable expense every year if there is a number of them, and it is for this reason the Author would only plant

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them in such positions where other trees would not do well; for instance, no other kind of tree should be planted where the subsoil has been affected by coal gas. There is one exception to the poplars, viz. the balsâm poplar, which has a different growth to the others, inasmuch as the lateral branches are not straight, the leaves are much finer, and generally makes a better road tree; unfortunately in light soils it is subject to canker; in heavy soils it makes a very effective tree.

Elm.—In light soils elms have a tendency to die off after they have attained full growth; with the exception of the Wych and Camperdown species, they are of slow growth; the latter, however, are to be recommended, as they are of fairly quick growth, have a long clean trunk, thereby saving pruning, and the lateral branches have a drooping character, giving a sort of umbrella shape to the foliage. At Eastbourne the Author saw that elms were largely planted in the roads; they had, however, a peculiarity about them, and on inquiry, the Author was informed they were Huntingdon elms; whether they were old friends changed by reason of subsoil or other cause, and a new name given them, or whether they were really a species with which he was not acquainted, he cannot say.

Lime.—This makes a splendid tree on sandy and dry subsoils, but as the roots are very fine and fibrous, it is impatient of moisture, and is not suited for heavy soils. On heavy soils it is subject during dry weather to sugar blight, the glutinous deposit of aphides; when this takes place, the dirt and soot deposited adhere to the leaves for the whole of the season, and spoil the beauty of the foliage. The Mississipi lime (*Tilia Mississipiensis*) is also a species that always thrives well on dry subsoils.

Birch.—There are many roads of narrow widths, say, 40 feet and under, where the birch, especially the silver variety, might be planted with advantage. The Author had the opportunity of seeing this lately, and a very pretty avenue they made.

Willow.—The three kinds mentioned in the Author's list make good road trees, and might be used with advantage at seaside places.

Ash.—Although it is seldom this tree is planted in roads, judging from those the Author has seen, he was much impressed with them. It has the advantage of few trees, viz. that it will stand sea air.

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PLANTING.

One of the great mistakes made in planting trees in roads, is that they are invariably planted too close; they should never be less than 25 feet for birch, some kinds of willows, and small growing trees, and at least 35 feet for the larger kinds, otherwise when full grown, the branches interlace with one another, and the symmetry of the trees is destroyed. When the trees are planted, the distance mentioned appears excessive when the trees are small, but one forgets the room they cover when full grown.

Another great mistake is often made in what the Author might term the meagre way in which the planting is done; simply a small hole dug, and what is generally rubbish returned for the tree to grow in. If the trees are to be a success this part of the work must be done well. First dig a space 5 or 6 feet by 4 feet and to a depth of 2 feet to 3 feet. The reason I give a rectangular measurement is that, unless it is a gravel path, the hole has to be as narrow as possible across the path. Fork over the bottom of the hole, return any bricks or rough material that may be in the excavated soil, and fill up the hole with some good soil, maiden loam, or rotted trimmings of verges, with which a couple of barrowloads of rotten dung, if possible, might be incorporated; this should be well trodden as the hole is being filled.

As soon as the filling is of a sufficient height for the tree to be planted, the roots should be carefully spread out and the tree staked and secured; the remainder of the filling can then be done to the surface of the path, and the tree well watered. If the subsoil is clay and impervious, and the hole likely to be made a pound for water, it will be necessary to drain the bottom; if this cannot be done, it would be better to make the hole shallower, and not into the clay subsoil, to allow the settlement of water, as in a young state all trees are adversely affected by stagnant moisture.

The slighest movement of roots after a tree has been planted injuriously affects them; it is essential therefore that the staking should be securely done so as to prevent any swaying of the tree during high winds. There are, of course, all kinds of stakes and guards used, but the Author has a preference for a single pole, scorched for a length of 6 to 12 inches more than

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it is required to drive it into the ground, and a piece of small-meshed netting wound twice round the trunk for a height of 6 feet to prevent children cutting the bark. It is cheaper in the end to obtain trees of a fairly good size, say 8 feet of clear stem. One of the mistakes made is planting too deeply. In a natural state the young roots are seldom more than 6 inches below the surface, and this would be about the cover that should be given to the roots.

The trying time to young trees after planting is during the cold drying winds of early spring; during this period they should be well watered, and, if possible, a syringing or douching overhead on a warm morning would greatly assist them. Where the tree is bound to the stake a piece of rough canvas, which is sold for the purpose, should be bound round the trunk, so that the tar-cord or wire-tie shall not injure the bark, and every year a man should be sent round to loosen the ties, if necessary, to prevent injury to the bark of the swelling trunk. The best time of planting is undoubtedly as soon as the fall of the leaf takes place, in the late autumn, or as soon as the ground is in a fairly dry state, as early as possible in January or February; they should, however, never be planted when the ground is wet and cloggy; less failures for this reason will take place if the trees are planted during the fall of the year.

Trees of a rank growing kind, viz. poplars and some of the willow tribe, should be planted in soil without any enrichment, especially in narrow streets. Birch, in very narrow streets, should be treated likewise.

Pruning.

The most important work in connection with the growth of a tree is the pruning, as upon it depends largely its vitality, and the moulding of it, as it were, for the purpose it is required. To do this properly, a person requires to be fully acquainted with the principles of vegetable life, and it is for this reason the Author has described at some length the anatomy and circulatory system of a plant.

It is always advisable, if possible, to obtain the services of a man who understands this work, which, however, is very difficult, even among so-called gardeners; otherwise, one has to

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stand by and give directions while the man is doing the pruning. No pruning should be done during the first year after the tree has been planted, and not until the tree is in vigorous growth and has plenty of leaf surface, otherwise the removal of the latter will weaken the tree. The reasons for pruning are: first, the removal of any branches that are likely to be obstructions; and secondly, to increase the ultimate leaf area, or, as before described, to increase the number of lungs.

The only pruning necessary at first is to gradually remove as the tree grows the lowest branches, so that a clear stem of at least 12 feet is obtained, in order that the branches shall not form any obstruction to light or passing vehicles (on a bus route a greater height will be required). If the branch to be pruned is thicker than one's thumb, it should not be cut off close to the stem, but only a portion lopped, leaving two or three buds; next year the remaining portion may be cut away close to the stem, and the next tier of branches partly lopped: these should be entirely removed the following year, and the process continued until the right height is obtained.

When a sufficiently high clear space is obtained under the branches, the leader or central stem may have its end removed, or "stopped," which will cause the tree to grow in bulk and strength, so as to dispense with the supporting stake. This manner of pruning applies to every tree except a poplar (balsam excepted). All the lateral branches of a poplar except the leader must be stopped the first year to prevent the formation of the large lateral shoots which grow on this species of tree, and afterwards every strong growing lateral shoot should be cut back annually. This hard pruning causes the sap to break in other places, and the formation of a number of small lateral branches on different parts of the trunk and main branches; these must also be removed, otherwise a solid mass of foliage will be formed, too large for the stem to support, even with a stake, in windy weather. Pruning may be done to give the tree a symmetrical formation, but the Author prefers the tree to have a natural appearance; this, however, is a matter of taste.

Pruning should only be done to a limited extent; if the knife is used too much too great a loss of leaves takes place and the circulation of sap too is greatly checked; judicious pruning, on the other hand, means an ultimate increase of leaf and consequent circulation.

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The best time to prune, in the Author's opinion, is in the early spring as soon as the sap begins to rise, his reason being, that it is then better seen by the swelling buds where the cut should be, and frosts are not likely to be so severe to cause injury to the wound as when the pruning is done earlier. If the branch is too thick to cut with a knife an upward saw-cut should be first made under the branch, at the place where the limb has to be severed, to prevent it being splintered, and afterwards the downward cut made. The end of the severed branch should be cut smooth with a sharp knife, as a "callus" forms quicker on a smooth surface.

Pests and Diseases.

The Author fears that at present local authorities would not care to go to much expense in eradicating the pests which prey upon trees, these being chiefly caterpillars and aphides. Prevention, however, is better than cure, and the surest prevention is to have a healthy growing plant—the kind best suited to the locality; plant it well, see that there is no stagnant moisture where it is growing, water it during drought, and it will be found that few pests will attack it. The lime is an example: in congenial soil aphides rarely touch it, but in a heavy soil it will often be smothered.

DISCUSSION.

Mr. Jos. Hall: I have to propose a vote of thanks to Mr. Smythe. I am unable to criticise, as I agree entirely with the paper. One thing particularly I am pleased to see is the recommendation that Councils should purchase their trees as young plants, grow them on their own ground, make their own selection, and know exactly the stamp of tree they are having. The trees will then receive proper treatment, will be acclimatised, and such as are suitable; and will give an economy of one-half, or even more. I note that the Author refers to one tree, the ash, that is seldom planted on roads, but that where he has seen it he is much impressed by it. There is one other variety that is still more rare and still more valuable (*Fraxinus Ornus*), the flowering ash, which grows erect plumes of white

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flowers, and makes a tree which in the flowering season looks as if it is covered with snow. It is well worth going out of the way to obtain it. In his remarks on planting, Mr. Smythe does not warn you that the ordinary tree-planter will cut off some of the roots if he has the opportunity, because it saves trouble in digging holes.

Mr. A. SMITH: I beg to second the vote of thanks to Mr. Smythe. Some of us who are surveyors of small towns find, among other things, that we have also to be gardeners—in fact, a kind of jack of all trades. One has to understand, or try to understand as much as one can about various subjects, and when one has trees in the streets or parks in a small town where superintendent gardeners cannot be afforded, a paper of this kind must prove most interesting. Some of the effects mentioned in the paper I have found in actual practice. I have some 200 to 300 trees to be kept trimmed and pruned, and made to look as well as it is possible to make them. Some two and a half years ago I had the disappointment of seeing most of the trees of which I am speaking looking in a frightfully scrubby condition. Nearly all of them had been planted on made ground which had been filled in with mud, tippings of all descriptions, builders' refuse and so on. I had at that time very little knowledge of trees, or what they required, but I carried out a suggestion which may be useful to some of our Members, who have trees planted in new roads, and find they do not answer. I started, or rather the caretaker of the gardens started under my instructions, and made a 3-feet trench, digging 3 feet from the centre of the tree, and putting the trench round 3 feet wide, and then filling in with soil and sweepings which had become rotten, and putting gravel on at the top. If you had seen those trees two and a half years ago and to-day you would be greatly surprised. They have increased, not only in their trunks, but, though planted 20 feet apart, the branches are meeting. This shows that trees planted in bad soils, and with the sea air, can be made to become strong and good plants. We have most of the trees mentioned, and the lime, ash, sycamore and plane seem to be doing the best; and where they have been planted under conditions mentioned in the paper, seem to be thriving, becoming healthy, and in every way looking what a tree ought to look—respectable.

Mr. NORMAN SCORGIE: The greater part of the paper would,

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I think, have been more fitting for a botany class at a Technical Institute than a meeting of this sort. I have yet to find out that any local authority has the right to plant trees in public roads. I know it is done by a good many who are not subject to Local Government audit, but those who are may find a difficulty in having the cost surcharged by the public auditor. All I know is that there is a Bill before Parliament to make it legal to plant trees in roads. [The PRESIDENT: In London.] That is so. As regards Mr. Smythe's suggestion that we should obtain trees of young growth, it may do where you have plenty of land, but we cannot all become nursery gardeners in London. I certainly agree with Mr. Smythe that in many instances the trees are planted too close together. People having houses in the roads like the young trees planted close together, forgetting that they grow. I think the suggestion that the roots should be 6 inches below the surface is hardly sufficient. My practice has been to plant trees 12 inches, and they have been successful.

Mr. W. H. GRIEVES: I should like to add my thanks to Mr. Smythe for the very interesting paper which is before us to-day. Mr. Scorgie says it is his practice to plant trees a foot below the surface, but does not say whether the Local Government Board auditor has surcharged him the cost of his trees. In Buxton we are always planting trees wherever we can, and as far as I know the Council have never been surcharged, although we are subject, I am sorry to say, up to the present time, to the Local Government Board audit. I am hoping we shall be incorporated before long. I think the paper is interesting and instructive. The suggestion as to rearing trees from saplings would not answer in a place like Buxton. They would cost a good deal more than they were worth by the time they were planted in the streets. That is owing to the high position of the town; it would be too cold. We buy trees after they are eight to ten years old, 10 feet high, and about 2 to 3 inches diameter, and we may pay 3*s*. 6*d*. and 5*s*. each for them. Those most suitable for our climate are the limes and the sycamore; though there are a good many other varieties that do very well. I entirely agree with Mr. Smythe's remarks as to stakes and guards. I notice in many towns very expensive guards round the trees. I think the expense is too great where tree planting is carried on to any extent, therefore I agree with the suggestion of a single stake and a piece of small-meshed

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netting wound twice round the bark for a height of 6 feet. I have adopted ½ inch wire mesh-netting for that purpose, and it answers very well. After it becomes rusted it is a nuisance, but it can be easily replaced. We have a difficulty in that respect in Buxton. We have a large number of errand boys who ride about on ponies delivering goods, and we often find trees broken off at the top by the boys fastening the pony to the tree. I should like to add for Mr. Scorgie's information that under sect. 43 of the Public Health Acts Amendment Act, 1890, special provision is there made for urban authorities to cause trees to be planted in any highway repairable by the inhabitants at large within their district, and to erect guards or fences for the protection of the same.

Mr. A. H. CAMPBELL: I am rather surprised to hear the remarks of Mr. Scorgie. We who are not privileged to serve in the Metropolis are apparently leading the way, because some two years ago we were able to get through the Local Government Board the sum of 600*l.*, not for trees, but for the guarding and protection of trees. If you are entitled to guard you are entitled to plant trees. We all agree with the planting of trees in our large suburban boroughs, and there is no use in planting trees unless you guard them. The guarding of trees is an important question. You are only wasting the ratepayers' money if having planted trees you do not guard them efficiently. We found while a healthy tree costs us 4*s.* 6*d.* or 5*s.* the guards ran to no less a sum than 25*s.*—a price which practically prevented us from developing the useful and ornamental practice of tree planting. We set about designing guards of our own, of a permanent description, and we have now been able to provide a thoroughly good guard for 9*s.* 6*d.* In my district we planted 700 trees last autumn and intend to plant 1000 this autumn, so that the reduction effected in the cost of the guard is a very important matter. In diameter the guard covers the same area as the iron guard which used to cost us 25*s.*

The PRESIDENT: The difficulties are how close to plant the trees and where. Of course with young trees, if you plant them a considerable distance apart—30 or 35 feet—they look very scanty the first few years of their growth, and people say, "What is the good of planting these twigs in the roadway?" and if you plant them too close, in a few years they are obstructing one another. I think it is prudent not to plant them too close

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together, and should say that 35 feet for plane trees in London is sufficient. It is a good thing in planting trees to get rid of any water which may be lying at the roots. When planting trees in heavy clay I take a searcher and make a sort of funnel from the bottom of the hole, and fill the commencement of the funnel with rubble as a kind of filter to draw off the water, which otherwise would lie round the roots of the tree. Of course gas is one of the great enemies to trees in London, and in many streets the vaults under the footpaths leave little earth-space on one side of the tree roots.

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CREMATION.

By W. NISBET BLAIR, M. Inst. C.E., Borough Engineer, St. Pancras.

The subject of Cremation has been three times mentioned in the 'Proceedings' of this Association, namely, by the first President of the Association, Mr. Lewis Angell, who, in his Presidential Address in 1874 mentions that cremation had been recently advocated by Sir Henry Thompson. He thought the practice might shock English feelings and Christian traditions; but he was not prepared to say that it might not ultimately commend itself to the sanitarian.*

At the Nottingham meeting in 1886, a paper on "Municipal Work at Nottingham" was read by Mr. Arthur Brown, Borough Engineer, in which he refers to the removal of 1100 bodies from 700 square yards of land for a street improvement; this experience led him to form a very strong opinion as to the desirability of cremation, the present system of earth burial causing pollution of both air and water, and deserving of the utmost censure. The Author was in Nottingham as assistant to Mr. Brown at the time this improvement was carried out, and he also saw sufficient of the repulsive process of dissolution as it is effected by earth burial to convince him that from a public health point of view cremation is far preferable.

At the Annual Meeting at Leicester in 1887, a paper was read by Mr. W. Eassie,† in which he gives an interesting history of the different methods of burial adopted throughout the world in different ages. He quotes some figures as to the acreage in London occupied as churchyard and cemeteries, and the number of bodies per acre in various instances; and he also refers to the practice of cremation at various towns on the

* Vol. i. p. 37. † Vol. xiii. p. 274.

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Continent and in America, and reports the recent construction of the crematorium at Woking.

A discussion took place upon this paper, in the course of which additional information was given, and while the speakers were unanimous in generally approving of the process, bringing out many instances of the reproduction of infectious diseases of various natures by opening up for different purposes old burial grounds, there appeared to remain in the minds of some a sentimental objection, but even that was not held with great tenacity.

At the International Congress of Hygiene held in London in 1891, the subject of cremation was brought up by M. Georges Salomon, General Secretary of the Cremation Society of France, in a very complete paper, prepared with the object of securing a more general adoption of cremation; while, on the other hand, a paper was submitted by Sir Francis Seymour Haden, F.R.C.S., etc., taking the opposite view of the question, and advocating that legislation should provide for burial within the earth as the only legal mode of disposing of a dead body. On these papers an interesting discussion took place, concluding with a resolution "that the cremation of the dead is a rational and hygienic procedure which is specially called for where death occurs from contagious disease," carried by an overwhelming majority, there being only four dissentients. This was followed by formal resolutions calling upon the different Governments to remove legislative obstacles which still opposed the cremation of the dead.

The first crematorium in England was opened by the Cremation Society of England at Woking in 1885, and the number of bodies cremated annually increased continuously up to 1900, during which year 301 operations took place, the total up to the end of 1902 being 2119.

In 1892 a crematorium was opened near Manchester by a company, and since that date 657 cremations have taken place.

At Glasgow in 1895 a crematorium was opened by the Scottish Cremation Society; and in Liverpool one was also opened in 1896 by the Liverpool Cremation Company, Limited.

So far these crematoria have been opened by private companies, but under the provisions of local Acts, the Corporations of Hull and Darlington opened crematoria in 1901, and under

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similar powers the Corporation of Leicester also completed a suitable establishment in 1902.

Another crematorium was opened near London, at Golder's Green, in 1902, by the London Cremation Company, Limited, which is understood to be a branch of the Cremation Society of England.

The City Corporation of London have also taken up the subject, and the construction of a crematorium at the City of London Cemetery at Ilford is about to be commenced under powers obtained by private Bill in 1900.

The number of cremations carried out at these establishments during the last ten years shows a steady though slow increase year by year.

Crematorium.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	Totals.
Manchester	30	47	58	52	51	62	88	90	95	81	654
Glasgow ..	..	..	1	10	16	12	16	20	18	20	113
Hull ..	..	..	..	..	..	..	..	..	17	13	30
Leicester ..	..	..	..	..	..	..	..	..	..	2	2
Liverpool	..	..	..	2	10	27	23	40	40	54	196
Darlington	..	..	..	..	..	..	..	..	2	1	3
Woking ..	101	125	150	137	173	240	240	301	273	275	2015
Totals ..	131	172	209	201	250	341	367	451	445	446	3013

It may be thought that a fairly good progress in securing the extension of the system has been attained in this country, but we are slow indeed as compared with other countries. In the United States there are twenty-five establishments, at which about 2700 cremations per annum take place; in Italy there are twenty-seven crematoria; seven in Germany; two in France; three in Switzerland; two in Sweden; and one in Denmark.

In 1893 a select committee of the House of Commons was appointed to inquire into the sufficiency of the existing law as to the disposal of the dead, for securing a correct record of the causes of death in all cases. This committee took evidence both in support of, and against the adoption of cremation, and reported their opinion "that with the precautions adopted in connection with cremation as carried out by the Cremation

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Society, there is little probability that acts of crime would escape detection, but inasmuch as these precautions are purely voluntary, the committee consider that in the interests of the public safety such regulations should be enforced by law."

It was not, however, until 1902, that Parliament passed the Cremation Act, 2 Edw. 7, Ch. 8, which applies to England and Scotland, and authorises any burial board, council, or other local authority having the powers and duties of the burial board, and any local authority maintaining a cemetery, to provide a crematorium, to be used under regulations made by the Secretary of State. This Act came into operation on the first day of April of this year.

In October 1902, a committee was appointed by the Home Secretary to prepare draft regulations to be made by him in pursuance of the powers given by Section 7 of the Act. This committee held several sittings, and took evidence from gentlemen either already associated with existing cremation societies, or holding appointments which gave them exceptional qualifications to give valuable advice to the committee. Special inquiry was made into the question of cremation being used to destroy evidence of crime, and investigation was made into the facts relating to all cases of exhumation which had taken place during a long period of years, and while the committee admitted that no regulations could be formed which would entirely eliminate the risk, yet they concluded that regulations could be framed which would so far reduce the risk as to make cremation at least as safe as the existing method of burial, as in certain circumstances the law even now permits burial without certification of the cause of death.

The committee had before them the regulations already in force under which cremations took place at the various establishments in this country, as well as those applying on the Continent and in America. The draft regulations prepared by this committee are based principally upon the regulations of the Cremation Society, and accompanying these are various forms of application for cremation, and certificates to be submitted for approval by the authority. Regulations are also included concerning the maintenance and inspection of crematoria, the disposition of ashes, and the registration of cremations.

A blue book has been issued containing the full report of the committee, their regulations, and suggested forms of certi-

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ficate, together with the whole of the evidence submitted by witnesses, and particulars as to the practice in other countries.

Now that cremation has received the sanction of Parliament it is needless to discuss the points so often argued in connection therewith, as to whether the burning of the human body was contrary to Scripture, or contrary to the principles of Christianity, or contrary to our security by removing traces of death by poisoning, and it is not from any of these points of view that the Author ventures to suggest the subject as one deserving the consideration of this Association, whose Members are absolutely all working in the interest of public health.

It seems, when one has read a little of the history of cremation, rather a matter for surprise at our dilatoriness, that it has only now become a legally authorised practice in this country, after even centuries of our boasted civilisation, whereas we find that cremation was largely adopted by many of the earlier civilised communities, and where not universal, was generally practised by the richer classes, leaving the bodies of the poor to be otherwise disposed of. For instance, during the period of the greatest power of both Greek and Roman empires, when their education and civilisation attained the highest development, we find cremation adopted as a means of disposing of all the illustrious dead. A little book on the subject of cremation has been published by J. Harvey Simpson, Esq., secretary of the Manchester crematorium, in which he reviews in a most interesting manner the history of cremation, before dealing with the religious, medical, and legal arguments that have at times been raised against it. In this book he gives quotations from many of the classic writers describing the habits of different nations in different ages, and in several instances the actual cremation ceremony of the great public men, both rulers and authors, in Greek and Roman times. Mr. Simpson has kindly given the Author liberty to quote from his book, but it would be much more instructive to any of our Members who desire to give personal study to the question to obtain this book and digest the whole of its contents, for it contains really all the information that is necessary to enable one to come to a conclusion in reporting to one's authority, and deals with details which it is not necessary to quote at present.

It seems, from many conversations on the subject, that sentiment offers the greatest hindrance to the more general

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adoption of the process of cremation: there is a reluctance in the minds of many to depart from the hitherto general system of earth burial, which they regard with feelings of the deepest reverence, and in many cases it would be real cruelty to such feelings to attack the sentiment by a recital of the facts within the knowledge of most of us who have had experience in the removal of bodies long buried, but necessarily disturbed by engineering works or street improvements. To such, there cannot remain any feeling of respect or reverence for the system of earth burial.

It is not on account of difficulty in obtaining sufficient land for cemeteries that the Author considers it justifiable to urge the substitution of cremation for earth burial, it is entirely on the question of the health of the living. The pollution of the atmosphere is important, though not so commonly in the minds of those who have considered the subject so much as the pollution of underground water, and as so much of our water supply is taken from wells, its purity and freedom from any tainted source is of the utmost importance.

Another argument might be urged with very great effect, namely, the absolute destruction of the germs of contagious diseases, which is rendered perfectly certain where the human remains are destroyed at a temperature of 1800 to 2000 degrees Fahr., now attained in cremator furnaces. The resuscitation of disease by disturbance of the ground where many years before diseased bodies had been buried, has been proved over and over again, and even without intentional disturbance of such ground there is always the possibility of germs being brought to the surface, and dispersed in the air by natural action such as that of earthworms.

The risk of spreading infectious disease from a corpse is so far recognised that there is now legal authority for the removal to a mortuary in any case where the Medical Officer of Health considers it essential in the interests of the living to remove a body. It does not involve any great stretch of the principles of hygiene to demonstrate that it would be also for the benefit of the living that the bodies in all fatal cases of infectious diseases should be cremated.

The removal of the sick in cases of infectious disease to specially provided hospitals is now so general in the larger towns, that cases of death in the home are much less frequent

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than formerly, but they do occur from time to time, and in such cases it is obvious that the removal and disposal of the infected body should be prompt and effectual.

A very large volume of the objections to the wider adoption of these views would be removed if it were generally known under what circumstances cremations now take place in this country, and as it has recently been under the consideration of the council of the district which the Author represents, he has had the advantage of visiting the crematoria at Woking, Golder's Green, Hull, Manchester, Liverpool and Leicester, with some members of his committee, and these visits enabled a large amount of information to be obtained, which not only was of importance to the Authority for whom it was first obtained, but it may be also of interest to this Association.

So far as this country is concerned, there are really only two types of furnace adopted, namely, the "Gorini" furnace at Woking, and a modification of the same, but not differing much, at Liverpool; and the "Simon" furnace, which has been constructed at all the other crematoria in this country.

The "Gorini" furnace, described as a reverberatory furnace, is much the simpler in construction, consisting of a furnace about 4 feet by 2 feet 6 inches in which a coke fire is maintained, and in direct continuation of this furnace, separated only by a fire-brick bridge, is an incineration chamber, through which the gases of the furnace pass on all sides of the coffin, passing away from this downwards to a flue leading to the chimney. The whole structure of the furnace is about 16 feet long by 7 feet wide and 8 feet high from the floor. The furnace and incineration chamber and flue are lined with fire-brick, but the structure is contained within solid walls, strengthened by buck-stays and tie-bolts.

The "Simon" furnace, described as a regenerative furnace, is a much more complicated structure; it is about 14 feet long by 10 feet wide and about 16 feet high, involving the construction of a basement story. The furnace is placed at the base of the structure, and its gases pass into a large chamber in the centre of the block, and from this by five flues on either side, into a smaller chamber immediately below the incinerating chamber. Into this they have access not only through the perforated bottom, but through side passages, where there is admitted a quantity of air heated by its passage through the flues immedi-

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ately in contact with the central chamber, and capable of regulation as to volume, the object being to secure increased temperature by regenerative combustion in the incineration chamber. From this the gases pass away through a perforated arch, and by a series of down-cast flues on each side to the basement, where they converge into one flue leading to the shaft. It is difficult to describe in words such a structure, and it is even difficult to fully comprehend the method of construction and its objects by the study of a drawing; but the effect of such a large number of cavities in the structure, which may almost be described as a honeycomb, so far weakens the block that after only two or three cremations cases have been seen where the brickwork is badly cracked, and a few more repetitions of its use have a marked effect on the stability of the structure.

In all cases the chimney shaft is placed at some little distance from the furnace, so as to be clear of the main buildings. In order to secure a sufficient draught when first starting the fire it is found an advantage to have what is called a pilot fire at the base of the chimney: this is merely an ordinary coke fire with an arrangement of air ports to supply fresh air to this fire independent altogether of the gases passing through it from the main furnace. It is generally found, excepting at the first lighting of the fires, that there is practically no visible smoke during the process of cremation, and as the design of the shaft generally takes the form of an ornamental tower, it appears quite as an architectural feature rather than a plain chimney stack—in fact, in most of the cases the Author has visited, there is no suggestion at all of a chimney in connection with the buildings.

Woking Crematorium.

This, the first crematorium in this country, opened in 1885, belongs to the Cremation Society of England. Its site is about two miles from Woking station. Previous to 1886 it consisted of a crematory only, the funeral service having to be conducted before arriving at the grounds. In answer to a special appeal for support, the Society in that year obtained sufficient funds to enable them to provide a chapel together with waiting-rooms and incidental accommodation. It is situated in very pretty grounds of an area of about half an acre. The chapel is about

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48 feet long and 24 feet wide, constructed of red brick relieved with Bath stone. The cost of the building and furnace, including also a superintendent's lodge, was about 5000*l.*

The furnace in this case is of the type described as the "Gorini" furnace, and was designed by Messrs. Newland Bros. of Mincing Lane. About two hours is necessary from the lighting of the fires to obtain the necessary heat, and a further two hours is occupied in the actual incineration process, about one ton of coke being necessary for the whole operation, the charge for which is 5*l.*, with additional charges for urns of higher value, and for niches in the chapel, in which to retain the urns, or for a burial plot in the cemetery adjoining, for which the charges vary according to size and situation.

MANCHESTER CREMATORIUM.

This crematorium was opened in 1892 by the Manchester Crematorium Company. It is situated in Barlow Moor Road about four miles southward from the Manchester Town Hall, and occupies a site of about three-quarters of an acre. The buildings are of an imposing character, and include a large hall or chapel, with a gallery containing an organ, and on either side of the chapel are arched colonades providing space for a columbarium to receive the urns. The dimensions of this hall are 50 feet by 25 feet, and the side walls are also built in panels with recesses provided for niches to receive the urns. The furnace chamber is at the back of the chapel and contains two furnaces, one behind the other, which proves to be an inconvenient arrangement, as it is necessary in using the most distant furnace from the chapel to pass the coffin through the furnace-chamber of the nearer furnace, which of course must be cold at such a time. These furnaces are of the "Simon" type, and for each cremation about one ton of coke is required. The cost of constructing the whole of the buildings, but apart from the cost of land, was about 7000*l.* The charge for a cremation is about 5*l.* 5*s.*, but with a view to encourage the operation among those who cannot afford so much, a reduced charge of 2*l.* 2*s.* is made.

During recent years the number of cremations, varying between eighty and ninety-five each year, have enabled a small debt of the earlier years of the establishment to be paid off, and there is now a small balance in hand.

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Glasgow Crematorium.

This crematorium and chapel, belonging to the Scottish Cremation Society, forms the third establishment in this country, and was opened in 1895 in the Western Necropolis of Glasgow, at a cost of about 3000*l.* This establishment differs from all others in this country in two particulars: firstly, instead of the coffin sliding horizontally from the catafalque into the furnace-chamber, the catafalque is lowered vertically into vaults below; and secondly, the furnace is heated by gas produced on the premises from small coal by a process designed by the Mirrlees Watson Company of Glasgow. The production of the gas takes place in a separate apparatus from the incinerating chamber, where it reaches a temperature of 1800° Fahr. The charges for cremation vary from 2*l.* 2*s.* to 5*l.* 5*s.*

Liverpool Crematorium.

This crematorium, opened in 1896, belongs to the Liverpool Cremation Society, and is situated in Priory Road, adjoining the Anfield Park Cemetery, and by communication between the grounds of the crematorium and the cemetery it is possible to conduct the funeral service in either the Nonconformist, Roman Catholic, or Church of England chapel, instead of in the crematorium chapel. The building comprises a chapel, 34 feet by 24 feet, with an ante-chamber between that and the furnace-chamber, which measures 27 feet by 24 feet, adjoining which is a square tower inclosing the chimney shaft. The site occupies about a quarter of an acre, and includes a lodge for the manager of the establishment. The type of furnace adopted here is very similar to the Woking "Gorini" furnace, but some improvements, suggested by experience, have been made in the designs by Alfred Holt, Esq., M. Inst. C.E., the chairman of the company. The exterior of the buildings and tower is entirely in the local red stone, and of a pleasing design. By an alteration made subsequently to the original construction, the space below the chapel floor has been converted into a columbarium, to which access is obtained by steps at the end of the chapel; the advantages of the premises have thereby been greatly increased, for with the free access of daylight to the passages, into which

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this columbarium is divided, there is ample light to remove any suggestion of gloominess, and to show up the colouring of the marbles and mosaic patterns used in the floors and ceilings.

The total cost of the buildings, including the alterations to form the columbarium, has been about 8000*l.* The ordinary fee for cremation is 5*l.* 5*s.*, but in some cases a smaller fee is accepted.

Hull Crematorium.

The Corporation of Hull have the distinction of being the first corporation in this country to erect a crematorium, which they did in 1901 under powers obtained in a private Improvements Bill in 1897. It was first intended to erect the crematorium in connection with an existing chapel in the Western Cemetery, but ultimately this proposal was abandoned, and the crematorium has been constructed in the Hedon Road Cemetery, but on a reduced scale, for the reason that the amount available for the whole establishment on this site was limited to what had been provided for the crematorium only in the other cemetery, namely, 3200*l.*, but the borough engineer is certainly to be congratulated on the appearance of the buildings, which though small in plan, are very attractive in elevation. The chapel is only about 24 feet square, and adjoining it is the furnace-chamber, about 24 feet by 20 feet, containing one furnace of the "Simon" type, in which about one ton of coke is found necessary for each cremation, though an additional cwt. is sufficient if a second cremation should follow immediately on the first.

The charges for cremation are to parishioners 1*l.* 1*s.*, and to non-parishioners 3*l.* 3*s.*, so that in the case of the former the charge barely covers the cost of fuel and labour.

A part of the ground adjoining the crematorium is laid out most tastefully as an artificial rockery, in which it is intended to make provision for placing the urns. This rockery occupies about half an acre of land, and some of the cliffs are 20 feet in height, displaying what is apparently natural stratification, with fissures and irregularities in the outline of the cliff face in very clever imitation of nature. The main structure of this rockwork consists of old bricks from demolished buildings faced with a composition of lime, sawdust and sand, so proportioned as to set

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satisfactorily, while at the same time it can be easily cut to form the niches in any situation that may be selected by those desiring to dispose of their urns in this manner. The design and execution of this work were in the hands of Mr. Bricknell, Assistant Engineer, and the Superintendent of Parks and Cemeteries, Mr. Witty, and it must be acknowledged that the greatest credit is due to these gentlemen for their ingenuity and successful production of something entirely novel.

Darlington Crematorium.

This crematorium was also opened in 1901 by the Corporation of Darlington, but as it was not visited by the Author, he is unable to give any description of it.

Leicester Crematorium.

This establishment, belonging to the Corporation of Leicester, is of much more pretentious character than any other crematorium in this country. It was opened in 1902 in the new cemetery, Gilroes Road, about two miles from the centre of Leicester. The buildings form a long range, with a chapel at each end, and a square tower over the gateway in the centre, and the appearance of the buildings crowning the hill in the cemetery is most imposing. The crematorium is built in connection with the south side chapel, and contains an elaborately carved catafalque and screen over the opening to the furnace chamber. The furnace is of the "Simon" type, and requires six or seven hours to attain a sufficient temperature, using in firing about 14 cwt. of coke.

The charges for cremations are 2*l.* 2*s.* to residents in the borough, and 5*l.* 5*s.* to non-residents.

About 3000*l.* was spent on the crematorium alone, apart from the chapel and other incidental buildings.

Golder's Green Crematorium.

This is the most recent crematorium constructed in this country; it belongs to the London Cremation Society, who are spending about 25,000*l.* on the various buildings connected with

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the crematorium, such as a large chapel 70 feet long by 25 feet wide with a floor of black and white marble; a columbarium, four stories high, is in course of erection; and there are also dwellings for the superintendent and others of the staff. The furnace chamber already contains two furnaces of the "Simon" type built side by side, but it is sufficiently capacious to afford provision for two more furnaces behind the present ones when the necessity for additional capacity arises. In this case about five hours are required to heat the furnace, and from one to two hours for the cremation, about 25 cwt. of coke being required in all.

This company charges 5*l.* 5*s.* for a cremation before 4 p.m. and after that hour 4*l.* 4*s.* Visitors are admitted to inspect the buildings at a charge of 6*d.* each, and no doubt a tangible revenue will be thereby produced as at the Manchester crematorium.

City of London Crematorium.

The Corporation of the City of London have had the subject under consideration for some time, and last year adopted the report of the Sanitary Committee which recommended the construction of a crematorium at the City of London cemetery, Ilford, in accordance with designs by the City Engineer, D. J. Ross, Esq., and contracts have now been entered into for the erection of the buildings at an estimated cost of about 7000*l.* It is provided to erect a chapel, 25 feet by 24 feet, with a furnace chamber in the rear, 37 feet by 30 feet, giving a capacity for two furnaces of the "Simon" type. A tower also to give some concealment to the chimney is provided, and adds very much to the design of the buildings. Waiting rooms are also provided.

After most careful consideration of the whole subject, and with the information in their possession obtained at the various crematoria visited, the Cemetery Committee of the St. Pancras Council have come to conclusions, recommending that an additional chapel with crematorium and waiting rooms be erected at the Finchley cemetery; that provision be made for a columbarium; that the crematorium shall contain two furnaces built side by side of the type in use at Liverpool.

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These recommendations have not yet been accepted by the Council, but even if an approving decision be not immediately arrived at, there is little doubt it will be ultimately accepted, as the erection of an additional chapel in the very extensive cemetery under their charge will be necessary owing to the distance of the existing chapels from the ground which will shortly have to be opened for the purpose of burial.

DISCUSSION.

The PRESIDENT: I have to thank Mr. Blair very much for responding to my request to him to write a paper on this subject. I think it is a matter which should receive the attention of the various authorities who desire to deal with the sanitary matters of their district.

Mr. J. T. EAYRS: It is imposible to speak with any personal knowledge of cremation. Personally, I should be very glad to come back after I had tested it, and no doubt many of the Members would like to do the same. We are very much indebted to Mr. Blair for the information contained in the paper, and I am exceedingly pleased to find from the return of cremations from 1893 to the present time that it shows a really marked progress in this method of disposing of human remains. Personally, I believe thoroughly in cremation, and should have been glad to have seen it make even greater strides than it has at present. One thing which will bring the system more into favour is the reduction in the charges for cremating bodies. At Hull the cost is only 1*l.* 1*s.* I do not know if Mr. Blair could add anything as to the construction or merits of the Gorini and Simon type of furnace. If they had been illustrated by drawings, one would have been able to appreciate the difference, and to understand the reason why the Gorini furnace was preferred to the Simon furnace in connection with the report at St. Pancras.

Mr. J. LEMON: I think if we were to take a vote "aye" or "no" whether we would be cremated and send it to the Cremation Society, that form of disposing of human remains would make great strides. I am in favour of cremation, but there is one objection with which perhaps Mr. Blair will deal—

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that is, poisoning. You know cases of poisoning have been brought home and people tried and hanged for the murder from the evidence obtained from the dead body, whereas if the body had been cremated that evidence would not have been forthcoming. That is the objection to it. On sanitary grounds we must all support it. It is a step in the right direction, and as we become educated up to it, we shall find that cremation will supersede the present insanitary disposal of human remains.

The PRESIDENT: This, as I have already said, is a subject well deserving serious attention. Like many reforms, prejudice stands in the way of its adoption; but I think it would be to the benefit of everyone if the dead were taken away from the proximity of the living as soon as possible after death has taken place. There is not the slightest doubt that among the poor the greatest prejudice exists against taking the dead away, and it is founded more upon prejudice and what will the neighbours say than upon anything else. If the dead body could be removed—in many cases from the one room where the family have to take their meals—it would be a great advantage to the living. If people were educated to take a proper view of the question, cremation would make more rapid advance. It is, however, making progress, but chiefly among the educated and wealthy classes.

Mr. W. NISBET BLAIR: I felt in preparing this paper that it was not one which would entirely attract the sympathy of the Association; at the same time I felt it was a subject which did deserve some consideration, and the more one is brought into actual knowledge of the conditions which follow the earth to earth burial of the past, the more one is convinced that the practice is entirely wrong, and that it is absolutely baneful in regard to the health of the living. The subject has recently been discussed by my borough council, and every speaker, except one, spoke enthusiastically in favour of our erecting a crematorium at our cemetery at Finchley. One speaker particularly attracted my attention. He is the minister of a dissenting congregation, and one from whom you might have expected a strong support of the old form of earth to earth burial. On the contrary he adopted a strong line in support of cremation. He stated that until he rebuilt his church, which covered the site of an old burying ground in Tottenham Court Road, he was as strongly hostile to cremation as it was possible to be, but that experience,

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and what he saw displayed of the dead buried there for many years past, had convinced him of the mistake of that method, and he was now as strongly in favour of cremation as he was formerly hostile to it. I think everyone who has had experience of the removal of dead bodies in the course of engineering work will realise the repulsiveness of what you find there, and how any sentiment can remain in the minds of those who have had that experience is a mystery to me. It is somewhat a diversion from the usual tone of our discussion, and does raise ideas which are quite unusual in our meetings. The respect we have for those who leave us is not for the body, and we should dispose of the body in a manner which is best for those who remain. Our attachment should be to the higher part of our being and not merely to the fleshy shell. Turning to the discussion to-day, there is very little arising out of it. As to the difference of the furnaces and the suggestion that illustrations might be of use. The Siemens furnace is a patented form of construction, and so also is the Gorini furnace. I did not, therefore, feel at liberty to illustrate my paper by designs of patented objects, and while I tried to describe in words the setting itself, it will be very easy for those who wish to follow it up to obtain these patented designs from the makers. Liverpool has adopted a furnace designed by Mr. A. Holt, which is based on the Gorini furnace, and he is quite willing to allow anyone to make use of his designs without any royalty or consideration whatever. The essential difference is this: up each side of the Simon furnace are ten flues, each of them about 6 inches square. Now when you imagine a block of brickwork perforated from top to bottom with ten flues and three chambers 8 feet long, 2 feet high, you can imagine there is not much solid brickwork left. The result is, after the furnace has been lighted a few times, the brickwork is shattered all over, and after two or three times use it requires repair, and within a year of opening, although comparatively few cremations had taken place, the furnace had to be rebuilt. The Gorini furnace has not anything of this intricacy about it. It is like an ordinary boiler fire, and rising from it over a bridge is a chamber to receive the coffin. The coffin rests on iron bars which rest on a little shelf on each side, so that the gases in combustion can pass on all sides of the coffin and then pass away to the chimney. There is no difficulty about that construction at all,

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and it is not subject to those quick variations in temperature which the lighter construction of the Simon furnace gives way to. In regard to the destruction of evidence in cases of poisoning, that was dealt with very fully indeed by the special commission which discussed the question and also by a more recent departmental committee who met by direction of the Home Secretary to prepare the regulations which he is required to make by the Act of last year, and which require the confirmation of Parliament before cremation is allowed to take place in any crematorium erected under the powers of the Act. Those regulations I do not quote in the paper because they are not yet confirmed, but they embody three methods of certification before cremation can take place. The first is the ordinary medical certificate stating the cause of death by the medical man in attendance on the deceased. That in the case of cremation must be supported by another certificate by an independent medical man, who will say he has seen the medical man in attendance, he has examined the body, and is satisfied with the certificate of the cause of death. The second is to make an autopsy and to certify the cause of death. The third is by a coroner's inquest. The commission say the regulations now in force, made by the Cremation Society of England, and approved by the Home Office, provide at least as great security against the burial or disposal of bodies so as to conceal crime, as the existing law provides in the case of ordinary burial certificates, and they had no hesitation in saying that no fear need exist that the introduction of cremation on a much wider scale would facilitate such crimes as we read of a few months ago. The precautions taken were quite sufficient to give protection to the public. I agree with the remarks of the President that it is prejudice which obstructs the extension of this process. It is a sentiment in the minds of nearly everybody of respect for the dead, which I say is based incorrectly on the body rather than on the spirit. I might also, with the liberty that was given me, have used illustrations of some crematoria which have been erected, but I did not do so, as it is not a question of architecture we want to discuss but the process. There is no doubt it will prove more economical, and that is a question of importance to the poorer classes of our large towns, than the unnecessary paraphernalia connected with the earth to earth burial.

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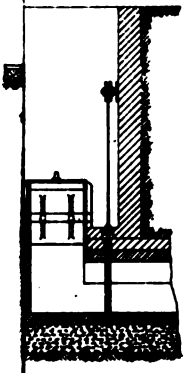

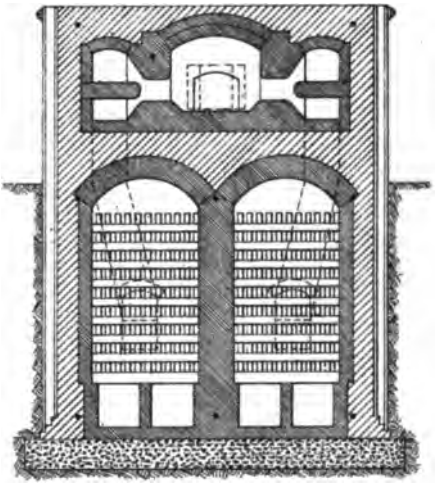

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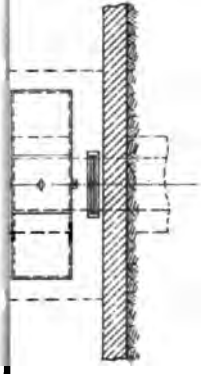

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COMMUNICATED DISCUSSION.

Mr. S. R. LOWCOCK: My experience enables me to entirely agree with the opinion the Author expresses in the second paragraph, and I think it must be obvious that the practice of cremation will largely increase. At present, however, in this country the number cremated is so small that I think the St. Pancras committee is wise in adopting the simplest form of furnace possible, as the saving in time and fuel effected in a more elaborate form of furnace would probably be more than counterbalanced by the cost of repairs rendered necessary by repeated heating and cooling for each operation. When cremation becomes more common a regenerative gas furnace, such as I have shown on the diagram, somewhat similar to a steel melting furnace, will I think be used. With a good number of cremations per day such a furnace could be kept continuously hot, and the cost per cremation would be very small, while the racking strains on the furnace due to heating and cooling would also be very small, so that an increasing number of cremations will of itself decrease the cost and thus help to increase the popularity of the process.

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MINIMISING THE RISK OF FIRE IN TEMPORARY BUILDINGS.

By T. W. ALDWINKLE, F.R.I.B.A.

There has been for some time past a growing feeling of uneasiness as to the danger from fire in connection with buildings of a temporary character, and at the request of this Association the Author has written this paper in the hope not only that it may contain a few useful suggestions on the subject, but also that it may form the basis for discussion of a practical nature.

It will be necessary at the outset to define what is meant by the expression "Temporary Building." It may be fairly described as a building which, being required only for temporary purposes, and having necessarily to be erected as quickly as possible, and in the majority of cases as cheaply as possible, is constructed of materials, and in a manner quite different from an ordinary building, and is generally of a flimsy rather than of a substantial character. In other words, it is not built to last.

These buildings are put to various uses, such as churches and chapels, lecture halls and mission rooms, hospitals and the like, and are all more or less of the nature of public buildings, wherein the public pass some hours in large numbers during the day, or where, as in the case of hospitals, the buildings are occupied by patients both by day and night. In all these cases, it is a public duty to see that the risk of fire in such buildings should be as slight as possible.

These buildings are all necessarily at variance with the London Building Act, 1894, and with the Building Bye-laws of the Provincial Local Authorities. In London they can be erected under licence from the London County Council, who must previously approve the plans, and the Author is under the impression that the same rule holds good in the provinces. There is, however, in the Model Bye-laws issued by the Local

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Government Board a special clause exempting from the operation of Local Building Bye-laws all buildings erected temporarily for the accommodation of persons suffering from dangerous infectious diseases, and this has been adopted by many local authorities in the provinces. (Of course, this does not apply to London.) Thus it happens that a good many of these temporary isolation hospitals must have been erected without any official control or supervision. Where these buildings are erected, as in London, under licence, such licences are frequently renewed from time to time, the result being that many of these buildings originally intended to stand for a short period, and, indeed, built with that end in view, have been standing for several years. Some of those still standing are, doubtless, of a fairly substantial character, but others are undoubtedly of a flimsy nature.

The temporary building of the ordinary type may be thus briefly described:—

The external walls consist of fir quartering or light iron framing covered externally with boarding, felt, and corrugated iron, the boarding being frequently omitted. These walls rest sometimes upon brick and concrete bases and sometimes upon wooden stakes driven into the ground; occasionally the external covering consists of boarding only without corrugated iron. The roofs consist of light iron or timber framing covered with boarding, felt, and corrugated iron, the iron being sometimes omitted and tarred felt substituted. The floors, which are of deal, rest upon fir joists on occasional brick piers, leaving an air space between the floor and the ground beneath.

The internal linings to the walls and ceilings generally consist of thin match-boarding, which is either painted or stained and varnished, thus leaving an air space of about 4 inches between the inner lining and the outer covering of the walls. Thus it will be seen that the whole of the interior of the building, walls, ceilings and floors, is lined with thin wood of necessarily a highly inflammable nature, the matter not being improved by either paint or varnish.

The method of warming frequently consists of open stove in the centre of the hall or room, with an iron flue pipe going through the roof.

Where there is more than one building, as in the case of an isolation hospital, the pavilions are generally connected by covered ways of mostly timber construction, and if there is a

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central system of hot water supply and heating, the steam and hot water pipes are laid in a subway, the floor over same being of wood.

Thus we see that by the very nature of the construction of these buildings, the fire is already laid and only requires to be lighted.

That when a fire *does* break out in these buildings, the destruction is swift and complete, we know already from the lamentable fire at the Colney Hatch Lunatic Asylum. By the courtesy of the London County Council Authorities, the Author was enabled to make a careful inspection of the ruins of these buildings, and as he had been responsible as architect for the erection of some nine or ten acres of temporary buildings during the past few years, he felt, as he looked upon the absolute and complete destruction of what had once been well erected buildings, that some lessons must be learned from such a catastrophe.

As we now know what is the usual construction of these buildings, let us now consider what steps can be taken to minimise the risk of fire in the future, both as regards new buildings to be afterwards erected, and as regards those now standing; and we will first of all deal with new buildings. Now, it must be borne in mind that two very important considerations are involved, viz. speed and cost. To take the case of an isolation hospital, that may be required to meet an immediate outbreak of infectious disease. The whole value and usefulness of this hospital would be lost unless it could be erected in a few weeks, and a high rate of cost would be prohibitive.

The Author would regard as a mistake any attempt to make these buildings fire-proof in the sense that we should make an ordinary building fireproof. But a little consideration will show that it is quite possible, without a prohibitive rate of expenditure, to very considerably reduce the risk of fire, and that without delaying the erection to any serious extent. The necessary steps to be taken will undoubtedly add somewhat to the expense of building, but not so seriously as might be surmised; but this must not in the future stand in the way of the provision of reasonable safety for those who occupy these buildings.

What should be aimed at is such arrangements and the use

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of such materials as will not admit of flame spreading from the point of contact with fire, to a point out of contact with fire in the same building, and to prevent the spread of fire from one building to another.

It is not proposed to materially alter the general construction of these buildings. Considerations of speed, will, as a rule, keep us to timber framing or light iron construction. (If timber framing is used this might be "treated" so as to become non-flammable. As this operation, however, costs about 2*s.* 6*d.* per foot cube, it would about double the cost of the timber.) But it will be possible to get rid of one source of danger, viz. the hollow external walls. These hollow spaces form flues and shafts for the passage of flame. There would be no difficulty whatever in filling in this space with brickwork either 3 inches or 4½ inches thick, making a solid or brick-nogged wall, which will also act as a non-conductor of heat and thus obviate the necessity of using felt as an external covering, this being an inflammable material. In place of brickwork this space could be filled in with concrete slabs; but whatever material (of fireproof character) is used, the great point is to obtain a solid wall.

Another important point is to insist upon there being no open space between the floor and the ground beneath, as this also forms an excellent channel for the spread of fire, in which case the wooden flooring is attacked on both sides. This space should be filled up with hard core finished with a layer of coke breeze concrete which need not exceed 4 inches in thickness, and the floor boards should then be nailed down direct upon the concrete. The whole would then form a solid mass upon which a fire could never obtain a firm hold.

As regards roofs, we must not forget that even in ordinary buildings they are a weak spot as regards fire, and that we cannot therefore hope to do very much in a temporary building. If, as we shall presently see, the ceiling can be formed of a non-flammable material, the danger of attack from fire will be principally from the outside, unless a fire breaks out in the interior of the roof. The roof would be covered with corrugated iron, and it would be a step in the direction of safety if the boarding under the corrugated iron were "treated" so as to become non-flammable. As will be seen later on, this could be done at a moderate cost.

The most important item, however, will be the internal

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linings of the building, that is to the walls and ceilings. As we have already seen, this generally consists of match-boarding. There can be no doubt that these linings are the most inflammable portion of the building, and that its danger in conveying flame cannot well be exaggerated. One of the most instructive pieces of evidence given by several of the nurses at the Colney Hatch inquest was that in which they described, with almost painful realism, the deadly progress of the flames along the match-boarding of the ward in which the outbreak of fire occurred. At one stage this fire was a small one, only to develop into a great catastrophe through the means of rapid transit existing at its disposal. It is, indeed, in this respect that a radical change must be made. Whatever else may be done or left undone, a remedy for this must be found in a practical and efficient manner.

There are fortunately ample means of dealing with this. It will be found that it will be quite possible to provide internal linings to these buildings which shall retard rather than assist the spread of flames.

In the first place, ordinary plastering is not a conductor of flame, in other words it is non-flammable, and this would be suitable for the walls and ceilings in those cases where speed in building is not of such great importance, but otherwise ordinary plastering not only takes more time than can be spared, but it seriously interferes with the work of other trades.

There is, however, another material which fairly meets our requirements as to speed, and is certainly a non-flammable material, and that is fibrous plastering. For the purposes of a temporary building these fibrous plaster slabs can be put up by hand, and neatly jointed and then distempered, the slabs being specially prepared for such a purpose at a very slightly increased cost. These slabs can also be made more fire-resisting by the substitution of wire netting for canvas backing at a little extra cost. This material would appear to be fairly suitable for the purposes of a temporary building, as it admits of rapid fixing and is not costly. In the case of infectious hospitals, it admits of all internal angles to the wards being rounded which is very essential for good sanitation.

In this connection it should be mentioned that in issuing their licences for the temporary small-pox buildings erected last year under the direction of the Author for the Metropolitan

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Asylums Board, the London County Council made a requirement that no match-boarding should be used internally, but only fibrous plastering or teak boarding.

Another excellent material for use as internal linings is "Uralite." This is a distinctly non-flammable material, and can be easily and speedily fixed. It requires, however, a good deal of backing in the shape of fir quartering or similar material, which adds to the cost. It does not lend itself to hospital work quite as well as fibrous plastering, but for all other purposes it is a material which has a great future before it, not by any means limited to temporary buildings.

Yet another method of lining the walls and ceilings is to revert to the match-boarding, but to have it previously "treated" so as to become non-flammable. Boarding so treated has been tested by the "Fire Prevention Committee" with excellent results. The cost of so treating the boarding does not exceed 16*s.* per square or about 2*d.* per foot super. This would appear to be a very simple and speedy method of wall and ceiling lining, and the only question is whether large quantities could be obtained in times of emergency.

The Author does not suggest that these are the only materials suitable for this purpose, but has mentioned them as being representative materials for non-flammable linings.

It may appear inconsistent to adopt these measures in relation of the walls and ceilings and to ignore the doors, windows and other joiner's work. But there is no need to be inconsistent. The whole of the joiner's work can be "treated" so as to become non-flammable. The wood is dealt with before it is glued up into doors, etc. Some idea of the cost can be formed from two instances. A 1½ inch door costs about 3½*d.* per foot super, and a 2-inch door about 4½*d.* per foot for "treatment." This is not a large percentage in order to obtain security.

As regards the finishings to all woodwork, it is most desirable that all paint used should be of a non-flammable character, and that varnishes should be avoided. There are several good paints of this character, and they do not appear to be more expensive than other paints.

It is most essential that passages and all means of intercommunication should be laid with some kind of fire-resisting material and in no cases with deal flooring. Cement paving

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laid upon well rammed hard core, not concrete, is a good and cheap material which can be easily and quickly laid. In the case of isolation hospitals, the ward kitchens and linen stores should be similarly paved. There is risk from fire in both these rooms.

Temporary hospitals generally consist of more than one building, and these are frequently connected by covered-ways. These should be avoided in all cases. They are of no earthly use as regards administration, and they may become the means of transmitting fire from one block to another; and the larger the number of separate buildings the greater the danger of covered-ways, as tending towards a larger conflagration. It should be pointed out that under no circumstances should these covered-ways, if adopted, be closed in at the sides. This is not necessary for ordinary hospital work. In the case of the Colney Hatch fire, the nature of the Institution and the class of inmates (insane patients) necessitated a connecting corridor closed in at both sides. Now, the temporary pavilions at this Asylum were 75 feet apart, and were substantially built, and under ordinary circumstances it would have been a difficult matter for the fire to spread from one building to another, but this closed corridor unfortunately acted as a powerful air shaft through which the flames, starting from the first pavilion, travelled to all the other pavilions with lightning rapidity and with such complete effect that the remotest buildings were quite as completely consumed as that in which the outbreak occurred.

As example is better than precept, it may be noted that at the Gore Farm Town Temporary Hospital, near Dartford, erected by the Author last year for 1000 patients for the Metropolitan Asylums Board, there are 82 separate buildings, but no covered-ways of any kind.

In all cases where there is a central system for warming and hot-water supplies, the pipes of the system distributing to the several buildings, should be laid in brick ducts, covered with fire-proof material. On the same principle all heater chambers in the basement should be protected with a fire-proof floor over the same. The use of the wooden joists and flooring over pipe ducts and heater chambers is exceedingly dangerous, as after a time the wood from its proximity to hot pipes has become so dry that it is highly inflammable.

Generally speaking, it is most desirable that temporary

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buildings should be erected in as substantial manner as the time will admit, and it will be found the truest economy to follow this principle in the majority of instances. That it is quite possible to erect buildings in a very short time and in which fairly non-flammable conditions may exist, the Author would refer as illustrations to the Mead Ambulance Station at Fulham, the Small-Pox Wards and Receiving Station at South Wharf, Rotherhithe, and the new buildings at the Gore Farm Upper Hospital, Dartford, erected under his direction for the Metropolitan Asylums Board, in connection with the small-pox outbreak of last year, at a cost of 100,000*l*. These were all built in twelve weeks. There is the ordinary timber framing to the walls and roof, covered with corrugated iron, but the internal linings to all walls and ceilings are of fibrous plastering or teak; all subways, pipe-ducts and basements are of fire-proof construction; all corridors have fire-proof floors, and all staircases are of teak. If this work had to be done at the present time it is probable that in the light of recent events, the external walls would be made solid in the manner already described, but no other alterations would be necessary.

So far as regards existing temporary buildings the matter is somewhat important, as they are so numerous. Some of these are of so flimsy a character that common prudence would suggest their immediate demolition, but there are many of these buildings which could be rendered less inflammable without incurring a large expenditure; so that one of two things should be insisted upon: either the buildings should be rendered safe, or they should cease to exist.

The first and most obvious remedy is to remove the whole of the internal wood linings; then, if funds admit, the external walls could be made solid in the manner already described. In any case, all the new internal linings should be of one of the non-flammable materials already mentioned. If this be done, the risk of fire will have been very considerably reduced, as the danger of fire to these buildings is from within rather than externally. The whole of the doors, windows and other internal joiner's work should also be painted with a non-flammable paint, the existing paint, if any, being previously burnt off.

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DISCUSSION.

Mr. W. NISBET BLAIR: This paper is of great practical value in these days when buildings are rushed up, working against time, in order to meet emergencies. From the experience of a few months ago at Colney Hatch we realise how serious indeed is the matter of fire protection of these temporary buildings. I have read through this paper, but I do not see that Mr. Aldwinkle has referred to that method of protecting wood by impregnation by some patented material, of which many of us have had samples sent. I have tested one of these samples, and undoubtedly it does prevent the wood so treated from breaking into flames. You may put the wood so treated into the fire, and it will char away, but will not break into flame. I do not know whether he has used wood so treated, and how he regards it. I believe Mr. Aldwinkle is a member of the Fire Prevention Association, and will have intimate knowledge of the work. Fibrous plaster slabs, or even ordinary plaster, we know does to a very great extent protect any wood so covered from fire, but I do not think it is altogether satisfactory, because, supposing the plaster gets broken, as we know it does, by the bumping of bedsteads into it in such places as hospitals, then it leaves the laths behind exposed to the risk of fire. The question of the extra cost of heating buildings would, in these temporary buildings, be an item to be considered, but still an increase in the cost is perfectly justifiable, and I do not think any one would hesitate incurring considerable extra cost to secure non-flammable buildings.

Mr. S. G. GAMBLE: I have not come prepared to make any exhaustive remarks on the paper, for the simple reason that it is so well written, and the conclusions drawn are so palpable to any ordinary mind, that it does not seem to need criticism. The only point that occurs to me in regard to the paper is, that it deals almost entirely with public buildings. Surveyors will know, more especially those in the provinces, that temporary public buildings are a very small proportion of buildings of this class that are erected. Public authorities can call in expert advice as to the protection of their buildings, and therefore there can be no excuse for their remaining for one day in a dangerous condition. The Author has mentioned the necessity

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of these buildings being run up in a great hurry, and without proper consideration of the many details of construction that can be worked out in permanent buildings, but I see no reason why a slight consideration of the chances of fire should not be at all times in the minds of the architect. It has fallen to my lot in days past to run up a small-pox hospital in forty-eight hours, without any preparation beforehand, and it can be done with materials to be obtained in any town. There is no reason why, during the construction of the building, or immediately after its erection, bricklayers should not be employed to fill in the partitions with 4½ inch brickwork, or better still, a 9 inch wall or two to divide the fire risk. A good 4½ inch brick partition is a very great protection in the early stages of a fire. The construction of corridors in connection with this class of building, demands the most careful consideration. The designers of temporary buildings do not often occupy them, and therefore do not understand the difference between walking from the administrative blocks to the wards during the day fully clothed, and answering an urgent summons from bed in the early hours of the morning with a north-east wind blowing. My brother, Dr. Gamble, undoubtedly lost his life through the want of proper protection in a hospital corridor. The staff should have proper protection, and I see no difficulty in such being provided, if a little brickwork is used to divide the corridor up into sections. Undoubtedly fire is a terrible thing, but I consider the smoke generated by the fire the difficulty and the danger to be guarded against. By cutting up these corridors into sections, and by using hardwood or armoured self-closing doors and brick walls, you can cut off the draught so as to make it possible, not only for the inmates of the building to escape, but for the attendants and firemen who attempt a rescue, to get close to the fire, and within striking distance with the extinguishing appliances. By designing buildings with these points in view, you may do much to minimise the danger from fire. We have not heard much of late about that terrible calamity at the Charity Bazaar in Paris, where so many ladies lost their lives. It is to buildings of that class, which are erected for charitable purposes and entertainments, that you must look for the greatest source of danger. At some of the bazaars which are held in permanent buildings, the stalls are erected in Japanese or Chinese fashion, decorated with flimsy draperies and paper lanterns. They are bad enough in

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all conscience, but when used in a temporary building, erected of timber, they provide a veritable death-trap. There is another class of building which has not been mentioned in this paper, that is the temporary stands erected on the occasion of processions or festivities. During the last twelve months, many of you may have seen with amazement, the forests of timber erected in the streets of London. While London passed through that time safely, I assure you the anxiety of those who had to look after the protection of the metropolis from fire, was considerable. You would hardly believe the time that was spent in the constant inspection of the stands. Special men were employed to watch them day and night, and at the same time every endeavour was made to keep from the public the fact that watching was being done. In the case of stands erected in a hurry and by contract, unless someone with a certain amount of authority is constantly watching the work, the joiner will leave his shavings there, the street newspaper vendor will throw his contents bills upon and under the stands, and you would be surprised how these accumulate in a large town, and especially in places where the wind forms eddies, and as thoughtless people still throw lighted matches away, these accumulations become a source of considerable danger. Should the weather be inclement and the timber soaked with rain, the danger is minimised. There is another class of temporary building not mentioned, that is the wretched sheds in yards and gardens at the rear of buildings. These are usually made of old egg boxes, bacon boxes or anything that can be obtained, and in which are stored all the rubbish, combustible or not, that can be collected in the streets or from the houses themselves. I hope I may depart from the subject of the paper for a short time to consider these open spaces at the rear of the dwellings, supposed to be provided for and considered to be absolutely necessary for the health of the people. Perhaps, as an old official in Leeds, I may be a little biassed, but going to Leeds, and seeing what are described as "the abominable back-to-back houses there," and seeing their cleanliness and safety from fire by the absence of these collections of stinking rubbish in the backyard, I cannot but consider there is much to be said from the fireman's—and, in fact, from a sanitary—point of view in favour of doing away with back yards. Then there is still another class of building not mentioned in the paper, viz. of the fellmongers' drying shed type

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built of lumber, and coated with tar as a preservative from the weather. They make uncommonly good bonfires when alight, and should in all cases stand far detached from other buildings. I have tried, as far as possible, to amplify rather than to criticise the paper presented by Mr. Aldwinkle. I may perhaps be asked, "If you consider these buildings dangerous, how would you suggest they be protected?" Well, the usual reply for the fireman to make is, "You must get a certain quantity of fire-appliances." They are in some cases absolutely necessary, and are valuable if you can rely upon trained persons to use them, but never forget that fire is never extinguished by polished copper or brass, or a large quantity of red paint, but by brains. It is to the individual using the appliance, and not to the appliance itself, that you must look for the extinction of fire. Therefore, while all temporary buildings should be provided with proper water supply and adequate appliances for the extinction of fire, it should be understood that the safety of the inmates must not rest upon the fire appliances, but upon the building being cut up into risks sufficiently small to allow time for the removal of the residents. The Author has told you that there are certain woods that can be treated, at a reasonable cost, and made slow-burning, but until these are to be obtained at a few hours' notice, they cannot be used in the construction of many temporary buildings, and, in the case of stands, most people want a seat at the lowest possible price, and it is hardly to be expected that the speculators will use expensive materials when the public will not pay the extra cost. We, therefore, come back to the fact that all temporary buildings should, from time to time, be inspected by officials who will take an intelligent and careful interest in their work. The older the building, the oftener the inspection should take place. It is quite possible that a temporary building has been erected with partition walls built to protect it, but a workman, in order to fix gas or water pipes, has made holes through the walls, and so undone, to a great extent, the protection afforded by the brick-work. Put your confidence in bricks, and you will find the more you do so, the less trouble you will have in the protection of your building from fire.

Mr. J. HALL: The question of fire safety is a very important one indeed, because buildings which are erected as temporary buildings may stand for many years. As an example, I have

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one experience which, though it does not come within the paper, is most valuable. A timber-built house, lathed and plastered inside and out, stood for eighty years, and was in a better condition at the end of that period than a brick house built at the same time. The closed corridor has been spoken of and criticised. There is one way of getting over that difficulty, that is to make your corridor with one wall, and putting that wall down the centre. Then your doctors and nurses can walk on the lee side. I would like to enter a word of protest against corrugated iron roofs for hospitals or for anything but storage purposes. During a storm the noise from such a roof is so trying, that after once observing its effect, if you have any feeling even for animals, you will never put them there again. What it must be to patients lying ill in bed is beyond imagination, as those in health do not fully appreciate how much it affects one's nerves. I would rather cover the roofs with boards and felt for the emergency, and then put on slates after the emergency was over—anything is better than corrugated iron. If the usual construction is followed and the timber framing be covered inside and out with small meshed wire netting or one of the methods of metal lathing, plastered outside with cement and inside with one of the quick-drying plasters, the work will be almost as quickly done as in wood, and the walls be sufficiently fire-resisting for the ordinary purposes to which such buildings are applied. The misunderstanding and confusion as to back to back houses in Leeds arises from the fact that the ordinary street with the houses provided with a back yard is made 36 feet wide as a legal minimum, whereas in Leeds you are required in most cases to have the houses 60 feet apart, and in this way obtain a wide open space between the opposite fronts, and that is really more valuable than anything you can do in the way of providing small spaces for each house. If once seen as carried out in some parts of Leeds very few would be inclined to condemn it.

Mr. C. H. Cooper: Mr. George C. Hale of the Fire Department, Kansas City, U.S.A., on page 93 of his Annual Report, 1901, states in reference to his European visit, "I believe that the people generally of the old world exercise much more precaution against fire than we do in America. Now the per centage of loss over there is about 30 cents per capita, and there are many cities in this country where it runs up to three dollars

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per capita. I believe that America could better profit by imitating their buildings than they can by imitating our appliances." I think that fairly bears out what Mr. Gamble has said as to the construction of buildings. In the case of two very serious fires that occurred in temporary buildings, namely, the Paris Bazaar and the Colney Hatch Asylum, the fire in each case spread in much the same way as the fire at the Royal Scottish Golf Club, Wimbledon Common. In these three cases the fire spread rapidly from one end of the building to the other, the space between the roof being unobstructed. I think if architects were more careful in cutting off the space between the roof and ceiling a great protection against the spread of fire would be effected. In the case of the Paris Bazaar, the whole building was in a state of fire in a few seconds. As regards partitions, I was rather surprised to find that reference was not made to wire lathing. I have used it in several buildings and continue to use it.

Mr. J. T. EAYRS: I am sure we are very much obliged to Mr. Aldwinkle for presenting this paper for the consideration of the Association. It is one which deals more particularly with hospital construction, and not with such temporary buildings with which municipal engineers have to deal all over the country. It is given to very few to have charge of the erection of hospitals, but I think most of the Members will have to deal with temporary buildings of one class or another in the course of their municipal duties. The point which struck me was this: the temporary buildings are not such as Mr. Gamble refers to which would be put up in brick, but are usually of wood construction, with corrugated iron used to a limited extent. If a person puts up a temporary building which under the law is exempt from the operation of bye-laws—and I believe that is the case of this type of building—what legal remedy is there, or what power has the surveyor of a local authority to prevent the erection of such buildings however liable to fire they might be? I was once told, when a very young man, by an old town clerk, "You should never bark unless you can bite." It is no use calling attention to these temporary buildings if you have no power to deal with them, because the owner will say, "mind your own business, you can do nothing." You are anxious about the protection of the buildings in case of danger to property contiguous to the buildings themselves. But if you have no power

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I fail to see where the remedy comes in. This is a useful paper for temporary public buildings erected by public authorities, because there they can use such protective measures as they are advised by their officers. I would like Mr. Aldwinkle to describe the methods of treating matchboarding so as to make it non-flammable at a cost of 2*d.* per foot superficial. I can understand that the Author did not wish to introduce the names of any patentees or special appliances, but at the same time I think it would be useful if two or three systems were mentioned, so as not to give any preference to one system over another. Mr. Aldwinkle has had opportunities of knowing probably nearly all the systems which have been brought out, and some Members would like to know the more modern methods of rendering buildings non-flammable. "Uralite," though a special patented article (see p. 331), is one I am specially impressed with. It is, I think, a composition of asbestos and silica. It seems to me the construction of buildings on some such system as that would render them fireproof and very substantial for temporary or even permanent work, and there would be no danger of fire from the use of this material.

Mr. W. H. GRIEVES: I would like to ask Mr. Aldwinkle what he would suggest should be done to a building I have recently had to put up in this manner. About twelve months ago I erected a temporary hospital building, with two wards for twelve patients, doctors' and nurses' rooms, bath, kitchen, etc. It had to be put up in a great hurry at the time the small-pox scare was going about the country. We spent over 500*l.* on the building. I should like to ask what should be done with a building of that sort in order to prevent it from catching fire, or in the event of a fire occurring to prevent it spreading. It seems to me that buildings put up in this manner, although they are called temporary, look as if they will stand for twenty years, and be good and substantial buildings. I do not think my Council will be prepared to pull the building down, although we did not receive the sanction of the Local Government Board to borrow the money.

The PRESIDENT: No doubt in his reply, either verbally or in writing, Mr. Aldwinkle will deal with the various points raised by the several speakers. To Mr. Gamble, from his intimate expert practical knowledge of the fire risks arising from buildings, we are indebted for the remarks he has placed before us.

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I agree with him that these bazaars which are held about the country are a source of danger. I have seen many in this building, with the stalls built of matchboarding, festooned with light draperies, and in the event of a fire breaking out the entire building would have been burnt out. As to the stands which were erected at the period of the Coronation, I can sympathise with the anxiety of Mr. Gamble at a time when one section of London was converted almost into stacks of firewood. If a fire had broken out it would have been a catastrophe. There is a considerable risk in these cases, and it must be to the fire brigade a time of the greatest anxiety. With regard to the wooden sheds erected in the rear of houses in London, it is a very great drawback that in London such buildings should be looked after by the district surveyors. As soon as they have received their fees for supervising the erection of the building under the Building Acts they have no further interest in the premises unless notice is given them of alterations, and the occupiers of the houses immediately begin to encroach on the space which the law has reserved for light and air, with pigeon-cotes, fowl runs, bicycle houses, and sheds for the donkey, etc. For years past it has been nobody's duty to see what was going on. Fortunately, the supervision of wooden buildings has now been transferred to the Local Authority, who are endeavouring to prevent the multiplication of these offences against public health. It is a very difficult matter. In the first place there is an Act which imposes a penalty upon anyone who erects these structures without a licence. Of course, people meet that by pleading Jarvis's Act and the six months limit. Then an Amending Act was passed (July 1898) which, under section 6, made it illegal to *retain* (as well as to erect) a wooden structure. Of course that Act cannot be retrospective and if the buildings have been put up before the said Amending Act was passed there is great difficulty in getting them pulled down. With regard to back-to-back houses touched upon by Mr. Hall, I do not think we need re-open that subject. I remember a paper on back-to-back houses which raised a great amount of dicussion with a variety of views as to the merits of the question. Then as to the point as to when a temporary building becomes a permanent one, that is a riddle which has not yet been solved. There are many buildings put up to meet panic demands in districts where the authorities can ill afford the outlay and are

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loth to pull such buildings down, but desire to retain them in order to meet a recurrence of the panic. These wooden structures, with corrugated iron roofs, go on year after year drying in the hot sun so that in time they are veritable tinder boxes. If these temporary aged buildings could be rendered non-flammable by turning the hose on and treating the wood with some non-flammable solution it would be a boon.

COMMUNICATED REPLY.

The Author proposes to make these brief replies of a general character. The question raised by the President as to when a temporary building becomes a permanent one opens up a very important point, viz. the present condition of these temporary buildings, and in respect of this Mr. Gamble's suggestion as to the periodical inspection of these buildings is an excellent one. In London, this would be the work of the London County Council, by whom the licences are granted, but it is not quite clear what power provincial local authorities have to interfere. But it is a matter of great importance, and if powers are wanting they should be obtained. Many of these buildings were only intended to stand for a short time, but as one speaker pointed out, once erected these structures generally remain, and as such are a great source of danger. There will be no excuse for this state of things in the future, as it is quite possible at only a moderate outlay to greatly reduce the risk of fire in these buildings. So far as the danger from fire in connection with bazaars, temporary stands, and the ramshackle structures put up in the back yards and gardens of dwelling houses, all these matters should be the subject of regulation by local authorities. The Author is glad that one with Mr. Gamble's great experience approves of the proposal to make all the external walls of these buildings solid with bricknogging. Another speaker appeared to prefer hollow walls, but experience of the Colney Hatch fire was strongly against the latter type of construction. In a test made by the British Fire Prevention Committee in 1889 (see pamphlet No. 22), with a hollow partition and a bricknogged partition, the results were wholly in favour of the latter. The question as to connecting corridors or covered ways, is an old and a vexed one, as regards hospital

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administration; but it cannot be denied that these afford excellent facilities for the spread of fire from one building to another. There must be, therefore, strong reasons for their retention. The best judges as to the necessity for such corridors are not the hospital authorities who possess them but those who *do not*. The Author will name two well known hospitals—the Belvedere Fever Hospital at Glasgow and the Eppendorf Hospital near Hamburg, both without covered ways. On visiting each of these establishments he was assured by the medical superintendent that they had no desire whatever for covered ways, and suffered no inconvenience from the want of them. As to internal plastering, the simplest method is, of course, to use that laid on in the ordinary manner, but this would be out of the question, in point of time, in the case of a temporary building erected at a great rate of speed. On this ground alone, fibrous plastering is suggested. This can be put up in large slabs and finished (for the time) in distemper. The possibility of danger arising from a fracture of this fibrous plastering, suggested by Mr. Blair, would not arise in the case of solid bricknogged walls. It is most desirable that the plasterings to ceilings, when not fibrous, should be laid upon metal lathing. It would not be necessary upon solid walls. The Author fully sympathises with Mr. Hall's objection to corrugated iron as a roof covering, and when time admits he always uses slating. The objection to using boarding and felt only, leaving the slating to be done at a "more convenient season" is that the boarding and felt generally remain, but the slating seldom arrives. The Author quite agrees with Mr. Cooper as to the construction of thin fireproof partitions. These can be made up of expanded metal and plastering on both sides, the whole not exceeding 2¼ inches in thickness, and at a cost not exceeding that of a half-brick wall without the plastering, and obviously of much less weight. The Author also fully agrees with his suggestion as to dividing up roofs so as to prevent them becoming fire conduits. The "treatment" of timber, boarding and joiner's work referred to in the paper is done by the Non-Flammable Wood Company, of Town Mead Road, Fulham. Very satisfactory tests were made by the British Fire Prevention Committee in 1899 with boarding treated by this Company (see pamphlet No. 36). With reference to Mr. Eayrs' remarks as to the paper not dealing with the ordinary temporary buildings to be met with in

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provincial towns, the Author would point out that the principles upon which these buildings should be designed and controlled are the same in all cases, for large and small buildings alike, the principal object being to prevent the rapid spread of fire from some small outbreak, and this can only be done by the use of materials unfavourable to the spread of flame. To Mr. Grieves' essentially practical question as to what should be done to a temporary hospital recently erected, so as to minimise the risk of fire, the Author would suggest that (assuming the building in question is of ordinary temporary construction, i.e. the walls and roofs of timber and corrugated iron, and the internal linings of deal) the whole of the internal deal linings to the walls and ceilings should be removed and replaced by fibrous plastering, and the internal joiner's work painted with "cyanide" paint. This would very greatly reduce the risk of fire. If funds admit, and the building is likely to stand for some time, the external walls should also be made solid as suggested in the paper, but under any circumstances the whole of the internal wood linings should be removed. These form a vehicle for the rapid spread of fire. The Author would also in conclusion desire to endorse the weighty remarks of Mr. Gamble as to the importance of relying upon the safety derived from a fire-resisting building, rather than relying upon fire extinguishing appliances. In this respect, prevention is certainly much better than cure.

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MOTOR VANS FOR MUNICIPAL PURPOSES.

By T. W. E. HIGGENS, Assoc. M. Inst. C.E.,
Borough Surveyor of Chelsea.

The question of providing mechanically propelled vehicles for the public service is one which should have the most careful consideration of all municipal engineers, especially those whose work lies in our large cities, where congestion of traffic in narrow roadways, and nuisance caused by horse droppings along the main lines of thoroughfare, are felt to be sources of danger and discomfort to all who use the streets.

The Author is strongly of opinion that, should the cost of working motor vehicles even approximate to that of horse-drawn ones, every local authority responsible for cleansing the streets should encourage their use, both on sanitary and economical grounds. More particularly should this be the case in populous London districts. A whole army of men and boys are there engaged in merely picking up horse-droppings; and the public are so accustomed to the sight, that the enormous expense entailed by it is hardly ever realised. But if motor vans and carts were substituted for only the horse-drawn vehicles now used for the purposes of the city and borough councils within the metropolitan area, an appreciable saving in the matter of street cleansing would ensue.

In an assembly of Englishmen it is an unpopular thing to speak evil of the horse. From the time when our prehistoric ancestors bore their victorious standard blazoned with a white horse across the hills and valleys of our native country, the fiery steed has always been held in honour by us. But after all, are there not many drawbacks to his unrestrained use in towns?

The Author has recently ascertained from a veterinary book that the excreta from a horse varies from 38 lbs. to 49 lbs.

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during the twenty-four hours, the greater portion of which must find its way into the streets. He has calculated that the horses in use by his council (the sanitary authority) distribute about the borough—one of the smallest in London—three-quarters of a ton of manure per day. For how many tons of horse-manure deposited in public streets are the sanitary authorities of London responsible?

Apart from the dirtiness of the creature, some account should also be taken of the very heavy wear and tear to the road surface caused by the number of feet attached to him, which would to a great extent be obviated if mechanically propelled vehicles were in use. What has been termed the "three-hundredweight hammers of iron-shod horses' feet" probably wear out every road twice as quickly as the iron-shod wheels of the vehicle which they draw; and in addition, as I have just mentioned, the horse is in itself the cause of a great portion of the offensive matter lying in the streets of towns.

It was not however, as you are aware, until after the passing of the Locomotives on Highways Act of 1896 that there was any possibility of the use of mechanically propelled vehicles becoming an accomplished fact in England. In the previous autumn the Author made certain inquiries, but no English firm appeared to be prepared to submit tenders.

Directly the Act was passed several English firms gave the matter their serious attention. Some devoted themselves almost entirely to pleasure vehicles; others made heavy vehicles their chief study.

The first firm to bring into use a motor vehicle for municipal purposes was, as far as the Author is aware, the Steam Carriage and Wagon Company, of Chiswick, now known as Thornycroft's Steam Carriage and Wagon Company, who designed steam dust-carts, two of which were at once used by the Urban District Council of Chiswick, and worked for some time in that district.

During the autumn of 1899 the Author obtained tenders for motor vans to be used either for dust removal or for ordinary cartage. The tenders were invited by public advertisement, and to enable them to tender each firm was supplied with the following conditions, in accordance with which they were asked to frame their estimates.

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Specification for the Supply and Delivery of Three Motor Vans.

1. The motor vans must come under the definition of light locomotives, as defined in the Locomotives on Highways Act, 1896,* and must comply with the regulations of the Local Government Board framed under that Act.

2. The vans are to be four-wheeled vehicles, provided with easily removable covers, and are to be of sufficient capacity to carry six cubic yards of sand or other material, of a weight not exceeding four tons. The extreme width of the vehicles is not to exceed 6 feet 6 inches, they are to be capable of going anywhere where a horse-drawn vehicle carrying the same load is ordinarily required to go. Each vehicle is to be completely under the control of one man, both for driving and steering, and is to be capable of being tipped by one man over a baulk of timber 14 inches by 14 inches, and held at any angle.

3. The vans will not be required to go at a greater speed than six miles an hour, and must be able to carry a load up an incline of 1 in 20 for 100 yards at a speed of four miles an hour.

4. Makers are not restricted to any kind of motive power, but must state which they intend to use, and must be prepared to guarantee that the cost of working, apart from the driver's wages, shall not exceed a certain sum per mile, to be named in the tender.

5. The tare weight of each vehicle must be given both exclusive of water or fuel, and also in full working order.

6. The body is to be of suitable seasoned wood, but the frame may be of iron or steel, and the top side-boards are to be hinged.

7. The inside of the platform is to be not more than 3 feet 4 inches above the ground-level when unloaded.

8. All working parts are to be properly encased.

9. The Surveyor to the Vestry shall be at liberty to inspect the vans at any time when being built at the maker's yard.

* To comply with the requirements of the Act the motor vans must be constructed:—

1. To weigh less than 3 tons when unladen, without taking into consideration the weight of water, fuel, or accumulators.
2. To emit no smoke or visible vapour.
3. To measure less than 6 feet 6 inches in width between their extreme projecting points.
4. To have flat tyres to each wheel, and if the weight exceeds one ton the width of the tyre is not to be less than 3 inches, and if two tons not less than 4 inches.
5. To be capable of travelling either forwards or backwards.
6. To have two independent brakes.

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10. The vans are to be painted as directed, and lettered "Vestry of Chelsea" in bold letters, and are to be delivered to the Vestry Wharf, Lot's Road, Chelsea; one, within four months of receipt of order, the other two within six months of receipt of order.

11. The vans are to be driven for one week after being delivered, by the maker's drivers, free of expense to the Vestry.

12. Payment will be made on the certificate of the Surveyor, as follows: 90 per cent. within one month of approval, and the balance within three months from the payment of the first instalment.

13. The makers are to enter into an undertaking to maintain the vans against fair wear and tear for a period of two years from the date of approval.

14. Tenders are to be delivered in a sealed envelope, endorsed "Tender for Motor Vans," before 4 p.m. on Tuesday, November 21st, 1899.

15. A drawing or photograph of the vans is to be submitted with the tender.

16. The Vestry do not bind themselves to accept the lowest or any tender.

The estimates submitted on this specification let the Author into the secrets of the motor van industry and the folly of Government restrictions. No one gave the tare weight of his vehicle and its weight in full working order.

There is no doubt that the motor van industry is sorely crippled by the 3-ton limit. If a somewhat heavier van could be built—and it is built, and used—a much more satisfactory vehicle could be produced, and one which need not do any more damage to the road than one within the 3-ton limit.

The Author considers that no object is served by fixing the weight limit of motor vehicles at 3 tons. A greater breadth of tyre might be insisted upon, and the weight of the vehicle increased to 4 or 5 tons. At the present time a very heavy weight can be put upon a motor vehicle weighing 3 tons with tyres 4 inches in width. It seems that very much less damage to the road surface would occur if the width of the tyre were made 6, 7, 8 or 9 inches, according to the weight of the vehicle.

Some years ago, the Chelsea Vestry had the misfortune to drop their steam-roller through some cellars under the street; they had a law-suit about the matter, and had to call evidence as to the weights carried about London by railway companies. The representative of one of the great railways said that they

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called heavy weights from 10 to 35 tons, plus the weight of the trolley; the weight of the trolley was from 4 to 10 tons, the width of the trolley wheels was about 9 inches, and the trolley would have four wheels, so that they had a total of 36 inches in width—which, supposing they had a load, including the trolley, of 25 tons (which the superintendent considered was not at all an exceptional weight) would give them about a ton per inch, and he further stated that he considered that a ton per inch would not be an unusual weight. Other evidence was called from large contractors showing that loads from 20 to 30 tons were carried about London by them. So it is quite evident that to adopt a 3-ton limit for a motor van when you may use a 6-ton horse-drawn trolley is unreasonable.

In the summer of 1900, the Author had two motor vans built to the following specification:—

Body.—The framing to be made of oak, the floor and sides to be of well-seasoned pine, the whole well supported with ironwork.

Covers.—To be of sheet steel, arranged so that they can be all removed, or separately slid.

Underframe.—To be of channel steel, 5 inches by 2½ inches by ⅜ inch, well stayed and riveted up throughout.

Tipping.—To be worked by double cut steel racks and pinions, giving sufficient purchase to enable one man to perform the operation.

Steering.—To be done by means of pivoted axles by worm and wheel gear.

Gearing.—To be of the finest bronze with machine-cut teeth, arranged for two changes of gear, which can be altered while the vehicle is in motion from the driver's seat. Both gears to be worked by a single levér, the wheels to run in an oil bath. With the engine running at 400 revolutions per minute, the fast gear to be equal to six miles per hour, and the other four miles per hour.

Engine.—To be compound, having cylinders 3½ inches by 6½ inches by 6 inches stroke. To be fitted with link motion, and have very large wearing surface. The low-pressure cylinders to be capable of being worked high pressure for starting or getting out of bad places. The engine to be entirely cased in and running in an oil bath.

Boiler.—To be coke-fired, and have 84 square feet of heating surface, and arranged for a working pressure of 200 lb. per square inch, and tested hydraulically during construction to 420 lb. It is

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to be arranged so that the outside shell can be taken out for cleaning purposes.

Firing.—The bunkers to be arranged each side of the boiler, within easy reach of the driver's seat.

Feed-Water Heater.—A large feed-water heater to be fitted, consisting of a copper coil enclosed in a specially designed case, the exhaust steam being passed through the case, and the feed-water heated to a temperature of about 180° F.

Water Tank.—To have a capacity of 100 gallons, which is to be sufficient for a run of about 12 to 15 miles.

These motors have been working since 1900, and are found to be most useful.

The Author has also had at work a steam motor van which has a frame built to take either a tipping body or water tank (700 gallons). This machine is one which has also proved very useful and economical. It cost 550*l.*, which included both bodies and a general guarantee against defects for the twelve months following delivery. It had been in work for some two years for various persons before the Author purchased it.

The use of such a vehicle is greatly to be recommended, and the Author finds that by a simple arrangement he can fasten a horse broom—or rather a revolving broom made originally to be drawn by a horse—to it, and thus water and sweep at the same time.

There are several motors used in London for municipal purposes, and the following are in use in the provinces.

The Liverpool Corporation have seven of the Lancashire Motor Company's vans. Six of these are in constant use for the removal of house refuse, each van being provided with a trailer, which is found to work without any trouble. Though used generally for removing house refuse, every opportunity is taken to send a load of materials, etc., back by the motors to some place near where they are working, as it is the extra loads so taken which make them pay. The city engineer has had one motor in use for some years, and his experience with this vehicle induced him to order six more. In Liverpool, cartage by motor vans is taken as a matter of course.

The Burnley Corporation have one of Messrs. Coulthard's vans. It was originally intended to carry ashes to their bacteria beds, which are some distance from the town; but on its journey it had to cross a country bridge which was not in a good state of

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repair, and consequently the county council objected to its weight. The corporation have therefore to restrict its use to their own borough. It is in use for general cartage.

The Blackburn Corporation have one of the Lancashire Motor Company's vans which is used to carry clinker to the sewage farm. It has worked very satisfactorily for a year, and has lately been running about 36 miles a day. They consider it a great success, and have another van on order from the same makers. The Author saw the motor carrying a load of 4¼ tons over very rough and hilly roads, but as the roads in most of the Lancashire towns are very rough and hilly, the motor makers look upon that as the normal condition under which their vehicles work.

There is no doubt that this van, having to go long journeys, is worked to great advantage. It is running most of its time at a pace which no cart-horse could keep up, and the time spent in loading is very short.

The Bradford Corporation have a Milnes lorry. It is used in the tramway department as a "tower" van to attend to the overhead electric wires, and it is regarded as successful in working. Being a petrol-driven van, it is not consuming fuel when standing in the street to allow the wires to be repaired. The Newcastle Corporation are also using a similar tower van for a similar purpose.

The Glasgow Corporation also use a Milnes lorry for collecting house refuse; but the superintendent seems to think that the time such a vehicle has to stand about being loaded is not favourable to economy.

One of Mann's patent carts has been supplied to the Corporation of Douglas, Isle of Man.

The Norwich Corporation have a wagon made by the Yorkshire Patent Steam Wagon Company, which is used for general work and for cartage to their sewage farm.

The Acton Urban District Council, the County Borough of Bournemouth and the Corporation of Bootle, use steam wagons made by Thornycroft's Steam Wagon Company, the latter corporation having two vans.

Motor vehicles have many advantages, but the chief is no doubt the speed at which they can work; and this is the reason why they must appear costly when used for street cleansing or dust removal in a small district. When used for these purposes

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the wages of the skilled mechanics who drive them adds greatly to the cost. These men only drive the motor; they cannot leave their vehicle to load it. If the motor driver were able to walk alongside his vehicle like a horse carman does when the slop van is moving along, and sweep up the slop; or if an unskilled man could drive a dust motor and leave it unattended while he collects the dust, the motor cartage by the council would be cheaper than horse cartage. But at present this cannot be done. Thus it is found that a motor which has to crawl along from door to door for dusting, or from heap to heap for slopping, is being used in the most unprofitable manner possible.

The Author is convinced that in a large district, or where the dust and slop shoots are situated at some distance from the place where the refuse is collected, motor vans will be economically used for this purpose; but when used for general cartage or watering, where it is possible to get eighteen or twenty hours' work out of the machine per day, they will be found to be a valuable addition to a borough engineer's plant, and well repay the large capital outlay expended upon them.

Mechanical traction has come to stay. It is completely altering the social habits of the so-called upper classes; all the large business firms are advantageously adopting this means of transport, and municipalities have no cause to lag behind.

DISCUSSION.

Mr. A. E. COLLINS: I have used a steam motor vehicle for some little time, and I find as long as I can keep it running that it is economical. But I find that the constant vibration and jar of the motor over the roads makes it very difficult to keep the steam pipe and other joints tight. The stoppages seem to be mostly for trifling matters, but they necessitate the laying up of the motor for repair, and that often means the loss of a day's work. I do not doubt that these are difficulties which will be got over when we get rid of the special vibration on the joints and pipes. That is one of the difficulties one has to contend with, in the use of motor vehicles in towns where there is a considerable mileage of not quite first class roads to travel over. I find for my purposes the most economical use of

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the motor is for street watering, where the machine is kept going practically all the time, as there is very little time occupied in filling the tank, and have also been using it to a considerable extent for carrying material to the sewage farm, a distance of about three miles, and I am satisfied with its work. For ordinary cartage for short journeys I do not think a motor pays, but that it is better to use ordinary carts.

Mr. C. H. COOPER: I had hoped that in a paper from one who has used motor vehicles for such a long time as Mr. Higgens, we should have some figures as to their economy and the particular purposes for which they might be economically used. Mr. Collins has mentioned street watering and long journeys, but in the paper itself we have not a single figure on which to found any estimate as regards the economy of using motor vehicles. I think it is very much to be regretted that the paper should be so deficient on that point. I think it is misleading to lay down an ideal that cannot be attained. Take the specification that Mr. Higgens has laid down for his van—a van to carry 6 cubic yards of sand at a weight not exceeding 4 tons. At the very least the sand will weigh 22 cwt. per cubic yard, and will give a gross weight of nearer 7 tons than 4. He objects to the Act limiting the width of tyres to 4 inches. Now if the width of the tyres on an ordinary motor could be limited to 2 inches, it would be a very good thing for our macadam roads. If you watch pneumatic tyres on a macadam road you will find, under certain conditions, the tyres suck up the small particles in the macadam; and the more you limit their width the more you limit the amount of damage done to the roads. Then he goes on to argue as to the weight and width of wheels of railway trolleys. You cannot compare the two things. Road trolleys go at a very slow speed, and the wider the motor tyres of their wheels the better. There is no reason why, because a railway road trolley has a wide wheel, you should allow a wide pneumatic tyre on a motor vehicle. Of course, provided they go at a low speed, there is no reason why a motor should not carry what load a road will bear, but if you allow the speed to be increased you must keep down the weight of your motor.

Mr. O. E. WINTER: I hope Mr. Higgens will supplement his paper with some particulars of the cost of working motor vans, as compared with ordinary horse haulage. Like Mr. Collins, I find with the two motor vans I have had in work for the past

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eighteen months there has been a considerable loss of time for repairs; with the two motor vans it has amounted to as much as 20 per cent. of the usual working hours, which is a serious drawback. The cost of repairs has amounted to over 70*l.* per annum for each van. I think some more suitable boiler is necessary to make them less susceptible to vibration. I find the most advantageous uses to which I can put them is street watering and the haulage of road materials. I have worked out some figures as to the cost of haulage of road metal, and I find, even with the disadvantages we have suffered during the last twelve months with heavy repairs, the cost of motor haulage works out at 1*s.* 5*d.* per ton, including all charges, as against similar work by horse haulage, 1*s.* 7*d.* per ton. Even under the present conditions the motors have an advantage, but, with further improvements and a more suitable boiler, the economy ought to work out more beneficially.

The PRESIDENT: Perhaps you will permit me to offer a few remarks in respect to the motor you will see at work in Cromwell Road. I mentioned in a former paper that I had obtained a steam motor, my desire being to introduce a machine which could be specially used for watering and cleansing wood-paved surfaces. That machine was obtained at a cost of 725*l.*, and my experience corroborates that of Mr. Collins. I find that while the machine is at work it does excellent work. An enormous area of wood-paved road can be cleansed by it during the night. But there are certain disadvantages: one being the very frequent breakdowns, chiefly of a trifling character, but necessitating stoppages for repairs, and interfering with the routine of the work. Another objection was the complaint as to noise. The latter objection increased to such an extent that I had to abandon the machine for nightwork; for, although it did not make so much noise as a van or an omnibus, yet in the quietude of the night the noise of the motor was very apparent, being accentuated by the absence of other traffic. In making this first machine of its kind the makers tried to carry out my ideas, but they under-estimated the strain put on the different working parts. Then the indiarubber squeegee, which worked behind the broom, revolved at such a rapid rate, that although it did excellent work, almost drying the road after washing, it would have been worn out in a fortnight. As the indiarubber squeegee costs 26*l.*, that is rather an expensive luxury, so I had

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to abandon the apparatus for cleansing, and had a second body made to the machine, so that I could take the water tank off when not using the motor for street watering, and put on an ordinary five-yard cubic body for carting sand, road material, etc., and that works very well. My experience is that it is very difficult to arrive at the actual cost of the various branches of the motor work as compared with horse work, owing to the work of the machine being so split up. I believe, with an ordinary motor, you would have a difficulty in getting makers to keep it in repair under 75*l.* or 80*l.* per annum, as the breakages and breakdowns are so frequent. I have no doubt Thorneycrofts will benefit from the experience they have derived, in a measure at the expense of my borough, and be able to design a motor of a very useful character. It only wants some improvements; it was too much to expect to get a perfect machine at first. In order that the Members may see the character of the work which may be done, I have had the cleansing attachment restored for the purpose of showing the machine working therewith.

The Members then proceeded in brakes to Cromwell Road, where they were afforded an opportunity of inspecting the motor combined watering, carting and sweeping machine. The motor was at the time employed in washing and cleansing the wood-paved road, doing a considerable stretch of wood pavement with great rapidity and thoroughness. Various types of water carts were also employed in watering the roads, among others, an old type of water van with new water spraying apparatus adjusted thereto. From Cromwell Road the next stopping place was the Old Brompton Road, in which a section, paved with blocks composed of clinker, refuse and Trinidad asphalte, was inspected. The section was laid in June 1902, *and was in capital order.*

The next visit was to the London County Council's new Pumping Station, Lot's Road, Chelsea. Mr. Maurice Fitzmaurice, C.M.G., M. Inst. C.E., Chief Engineer to the London County Council, has kindly furnished a description of the station. (*See Appendix.*)

The works of the Kensington and Notting Hill Electric Lighting Companies were then visited, after which the Members walked to the Generating Station of the Underground Electric Railway Co. (*See Appendix.*)

The visits were completed by an inspection of the Generating

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Station of the London United Tramways Co. At the completion of the inspection, the Members were entertained to luncheon by the Company.

In the evening, the Annual Association Dinner was held at the Holborn Restaurant. The President (Mr. W. Weaver) was in the chair, and among the guests were Sir Frederick Bramwell, C.E., Mr. Gordon, K.C. M.P., Mr. Bayley, and others.

The proceedings on Saturday were devoted to an inspection of the extensive Brickmaking Works of Messrs. Eastwood and Co. Ltd., at Conyen. The Members travelled by special train from Victoria to Teynham, where, on arrival, they were taken in parties over the whole of the extensive works of the Company, and were shown the new process of making, drying and burning stock bricks. After the inspection of the works the Members were entertained to luncheon at Sittingbourne.

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APPENDIX.

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THE LOT'S ROAD PUMPING STATION OF THE LONDON COUNTY COUNCIL.

By MAURICE FITZMAURICE, C.M.G., M.Inst.C.E.,
Chief Engineer to the London County Council.

The greater part of the districts of North Kensington, Hammersmith, Fulham, Walham Green and Chelsea is dependent on the Counters' Creek Sewer, which, on occasions of heavy rainfall occurring at times of high water in the Thames, into which it has a storm overflow, becomes surcharged, and consequently the local sewers are prevented from obtaining an unobstructed outlet.

The Counters' Creek Sewer forms one of the valley lines into the Thames, and is next in character to the Fleet on the north side of the river.

It drains an area of five square miles, and discharges the sewage from that area into the Low Level Sewer in Lot's Road. It rises near Kensal Green, Willesden, and runs in a southerly direction, having a length of about four-and-a-half miles, and at its lower end is 9 feet 6 inches by 9 feet in section, with an invert level of −3·22 O.D., discharging by means of a special chamber into the Low Level Sewer, which crosses it at right angles and at the lower level of −14·86 O.D. The levels at the eastern and western branches at their upper end are 94·57 and 141·90 O.D., indicating the rapid gradient of the sewer, and consequently the large volumes of storm-water brought down into the lower portion in times of heavy rain.

During the last ten years there has been a greater rainfall than 1 inch in twenty-four hours on nineteen occasions over the districts mentioned. The maximum fall has been 1·51 inches, and the average 1·28 inches, in twenty-four hours on these occasions.

The Low Level Sewer, where it crosses the Counters' Creek Sewer in Lot's Road, is a 5-feet barrel with an invert level of

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−14·86 O.D., draining from the west an area of four-and-a-half square miles. This sewer is also subject to much surcharging when heavy rainfall takes place.

The situation of the Lot's Road Pumping Station is close to the River Thames, and in such a position as to adequately command the storm waters in both sewers.

The building has a frontage to Lot's Road of 159 feet, and a depth of nearly 77 feet.

Adjoining it is the accommodation building for the staff, with a frontage to Lot's Road of 37 feet, and a depth of about 48 feet. This is a four-storey building, with basement.

The whole of the buildings, together with sewer connections and discharging culverts, have been carried out by the Works Department of the London County Council.

The machinery of the station has been designed and arranged with the object of preventing floodings, by lifting and discharging into the river the storm-water entering the Counters' Creek and Low Level Sewers, on those occasions when it could not flow by gravity into the Thames on account of high tide.

The engines and pumps in connection with each sewer are necessarily distinct, but the arrangements in each case are practically identical in kind, although not in size and discharging capacity.

It is calculated that during heavy storms some 12,000 cube feet of storm-water per minute will gravitate from the district of the Counters' Creek Sewer, and about 6000 cube feet per minute from the Low Level Sewer area west of this point.

As indicated above, there is in the two systems a difference in the levels from which the water has to be lifted—this is, normally, about 14 feet.

In order to deal with the above maximum quantities of storm-water, and to cope with storms of less than maximum force without waste of power, the machinery has been laid down in several units, each complete in itself. It was, therefore, considered advisable to control the rise of water in both sewers by means of four centrifugal pumps in each case, the pumps to be driven direct by ropes from gas engines.

It is judged, by similar but much smaller stations belonging to the Council, that this station will be at work for a period of about sixty-three hours per annum.

The pumping will necessarily be intermittent, and this and

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other conditions rendered the employment of gas engines with centrifugal pumps desirable and economical.

The four pumps emptying the Counters' Creek Sewer have suction and discharge branches 32 inches in diameter, and each is capable of discharging 3000 cube feet of water per minute. The four pumps emptying the Low Level Sewer have branches 23 inches in diameter, and each is capable of discharging 1500 cube feet of water per minute.

It was, of course, essential that the engines should be designed to give sufficient power for the pumps to lift the storm-water from the levels of water in the sewers to the height of the maximum tide-level of the river, which is taken as 14·60 above O.D. The lifts, under these circumstances, would be the maximum possible, and are, respectively, equal to 14·5 feet and 28 feet.

The larger pumps—i.e. those in connection with the Counters' Creek Sewer—are driven by engines each of 260 I.H.P., and the power of each of the engines driving the smaller pumps for the Low Level Sewer is 210 I.H.P. The cylinders of the respective engines are 18½ inches diameter by 30 inches stroke, and 18½ inches by 24 inches stroke.

Each engine is built on the "Otto" principle, and has twin cylinders. The speed will be 170 revolutions per minute. The fly wheels of the larger engines are 7 feet 6 inches in diameter, and grooved for ten 1½-inch diameter ropes, and the smaller engines have fly wheels of the same diameter, but grooved for eight 1½-inch diameter ropes.

Each engine has in connection with it a separate wrought iron circulating water tank designed to hold about 40 tons of water, and of the following dimensions: 15 feet long, 15 feet wide and 7 feet deep.

The dimensions of the engine-house, excluding that portion built for the accommodation of the circulating water tanks, are: 153 feet in length by 51 feet in breadth.

In order that the pumps shall be reasonably near to the suction wells, they have been arranged and fixed on a floor 20 feet 6 inches below the engine-house floor, in a chamber running the whole length of the engine house and along one side of the same. By this arrangement, therefore, the driving ropes run obliquely from the engine fly wheels down to the pump pullevs through deep races prepared in the engine floor, and

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there is a distance of 31 feet 6 inches between the pulley centres.

The pressure water for working sluice valves on pump deliveries is supplied from two duplicate sets of auxiliary gas engines, running at 250 revolutions per minute, and each driving through suitable intermediate gearing a set of 3-throw vertical rams, 1½ inches in diameter by 3-inches stroke, and delivering 1 cube foot of water per minute. The pressure water has a further use—namely, in operating certain penstocks in connection with the sewers. An accumulator, 8 inches in diameter by 5 feet stroke, forms part of the hydraulic arrangements.

The centrifugal pumps are charged by means of ejectors, which are worked by compressed air; the same medium being also used for starting the main engines. Two self-contained air-compressing engines are provided, each capable of dealing with 150 cube feet of free air raised to a pressure of 100 lb. per square inch.

The engines are each of 33 I.H.P. when running 170 revolutions per minute, and the air cylinders are 10 inches in diameter by 21 inches stroke.

Each of the main engines has a separate gas meter, and is also in other respects independent.

The pumping station being situated in a public highway, and in a residential neighbourhood, great care had to be taken to obviate all possibility of complaint due to the working of such a station. It was, therefore, deemed necessary to completely deaden the noise usually associated with a gas engine exhaust, by carrying the product of combustion into silencers placed in pits 10 feet 6 inches deep in the engine floor, arrangements being made to ventilate these pits by shafts connected with the outer air.

A 10-ton traveller, working by hand power and of a span of 52 feet, runs the whole length of the engine house, and is available for lifting the parts of both engines and pumps.

Information respecting the cost of the station and machinery may be interesting, and is as follows:

The pumping station and staff accommodation building were carried out by the Works Department of the Council at a cost of about 35,000*l.*

The pumps were supplied and erected by Messrs. Easton and Co., Ltd., at a cost of about 6100*l.*

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The engines, by Messrs. Crossley Brothers, Ltd., at a cost of about 10,300*l.*

And the traveller, by Messrs. J. M. Henderson and Co., at a cost of 380*l.*

It is expected the station will be completed and in working order before the expiration of the present year.

The work has been carried out under the direction of Mr. J. E. Worth, M.Inst.C.E., the District Engineer.

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DESCRIPTION OF THE CHELSEA GENERATING STATION.

THE SITE comprises 3·67 acres of land, with a water frontage on the Thames and on Chelsea Creek of 1100 feet, and a frontage on Lot's Road, Chelsea, of 824 feet.

The BUILDING is 453·5 feet by 175 feet, and 140 feet in height from the ground floor to the peak of the roof. The office building adjoining on the east measures 81 feet by 25 feet, and will have three floors, the lower of which forms the machine shops. The main building will have a self-supporting steel frame weighing about 5800 tons. There will be four chimneys, each 19 feet internal diameter and 275 feet high; the foundations for these chimneys are 42 feet square, and 34 feet 6 inches below the ground floor level. There are 2200 cubic yards of concrete in each foundation.

The capacity of the building at normal load is 57,000 k.w. On this basis the cubic feet per k.w. (including office building) is 139, and the square feet per k.w. is 1·36.

The steel frame of the building will be closed in with brick and terra-cotta; the roof and most of the floors will be concrete. In general details the building will be considered as a factory for the production of a commodity, and there will be no ornamental features.

BOILERS. The south side of the building will contain eighty water-tube boilers, arranged two stories high and carried directly on the steel frame of the building. Each boiler has 5212 square feet of heating surface, and 672 square feet of superheating surface. The boilers will be piped in groups of eight, each group supplying the steam for one electric generating set and one feed pump; there being no steam connections between the several groups, except that a supplemental header at the east end of the building is connected to two groups. This header supplies the exciter engines, air compressors, house pump, etc.

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Chain grate stokers under each boiler have 83 square feet of surface.

ECONOMISERS, with tubes 10 feet long, and placed wider apart than the usual practice, are grouped behind the boilers, with the customary bye-pass flues; 1540 square feet of heating surface is provided for each boiler.

BOILER FEEDERS are placed on the ground floor, and supply ring mains on both the boiler-room floors.

MAIN GENERATING SETS consist of a horizontal turbine engine, running at 1000 r.p.m., and a three-phase generator wound for 11,000 volts, 33⅓ cycles; there will be ten such sets, with floor space for one of half the size. The normal rating of each generator is 5500 k.w., but they will carry an overload of 50 per cent. for two hours at practically the same steam consumption per k.w.h.

EXCITER SETS. There will be four 125 k.w. 125-volt steam-driven exciter sets, running at 375 r.p.m.

THE CONDENSING SYSTEM consists of vertical condensers, each with 15,000 square feet of cooling surface; these are located in pits between the engine foundations. The circulating water is supplied by 66-inch pipes laid to the edges of the channel of the Thames. Each condenser has a 20-inch centrifugal pump; the duty of this pump is simply to overcome the friction of the pipes, as the system is arranged on the syphonic principle, the top of the condensers being within 29 feet of minimum low tide, and the circuit is closed.

The intake and discharge mains are arranged for reversible flow.

The condensers are designed to work on the dry vacuum principle, the air pump and the water pump being separate. All the condenser pumps are electrically driven.

The SWITCHBOARD is carried on three gallery floors extending across the north side of the engine room, with returns across the east end. All high tension switches will be motor operated, and the feeder system extending to the 23 sub-stations will be in duplicate. A line of 64 ducts is being constructed to carry these feeders to the nearest point on the District Railway at Earl's Court.

FUEL SUPPLY. Coal will be received on lighters in a tida basin at the east end of the station, or by rail at an unloading point of the West London Extension Railway on the opposite

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side of Chelsea Creek. For unloading barge coal the basin is spanned by two travelling cranes, each working a one-ton grab; the coal is weighed in the tower at one end of each of these cranes and dropped on to a belt conveyor, thence by duplicate inclined elevators 140 feet high to the top of the building.

Rail coal will be taken from a hopper under the coal wagons by an inclined elevator to the top of the building at the opposite end. The distribution over the bunkers is by duplicate belt conveyors, so arranged that the direction of travel of both belts can be reversed so as to handle coal coming in at either end.

The storage capacity of the bunkers is 15,000 tons. The daily consumption will reach 800 tons, and six of the largest river barges can be placed in the basin at each tide.

Ashes will be removed by an industrial railway worked by a storage battery locomotive; two lines of rails will be laid under the ash hoppers on the ground floor. The ashes will drop into self-dumping buckets, to be unloaded into barges by pneumatic hoists on the dock wall at the west end of the premises, or stored in an adjoining bin if no barge is available.

The capstans, barge-basin, gate mechanism, and many of the large valves in the building, will be worked by pneumatic motors.

The electric motors on the travelling cranes over the engines, as well as those on the oil switches, will be d.c. 125 volts. All other motors will be three-phase 220 volts; most of the lighting will be on the latter circuit.

It is expected that a portion of the plant will be in working order by the latter part of 1904.

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V

STATISTICAL RETURNS.

On the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W. Those marked thus * are in duplicate, and can be borrowed for perusal by Members on application to the Secretary. Those *not* marked * can only be inspected at the Offices.

N.B.—PLEASE QUOTE REFERENCE NUMBER.

(Members are requested, when sending statistics, to kindly send them in duplicate if possible.)

Ref. No.

ABBATOIRS (PUBLIC).

12. *Information from various towns. Compiled by W. Chapple Eddowes, Shrewsbury. 1902.

DRAINAGE CONNECTIONS (PRIVATE).

11. *Information from various towns. Compiled by H. Richardson, A.M. Inst. C.E. 1902.

DRAINAGE (HOUSE).

1. Information from 31 towns. Compiled by J. Atkinson, A.M. Inst. C.E., Stockport. 1894.

DRAINAGE (NEW BUILDINGS).

49. *Information from various towns. Compiled by E. J. Lovegrove, M. Inst. C.E., Hornsey. 1896.

FIRE BRIGADES.

36. *Information from various towns. Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.

HORSES (COST OF KEEPING).

2. Information from 29 towns. Compiled by M. Petree, A.M. Inst. C.E., Grimsby. 1896.

LIGHTING (ELECTRIC).

3. Information from 38 towns. Compiled by J. W. Brown, A.M. Inst. C.E., West Hartlepool. 1894.

4. Information from 88 towns and 10 London vestries. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth. 1891.

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Ref. No.

LIGHTING (ELECTRIC).

5. Information from 58 towns. Compiled by W. A. Davies, A.M. Inst. C.E., Aston Manor. 1893.

40. Information from 36 towns. Compiled by E. J. Silcock, A.M. Inst. C.E., King's Lynn. 1896.

LIGHTING (GAS).

6. Information from various boroughs. Compiled by J. W Bradley, A.M. Inst. C.E., Nelson. 1895.

7. Information from 38 districts as to undertakings in the hands of Local Authorities. Compiled by P. Ross, A.M. Inst. C.E., North Bierley. 1896.

LIGHTING (PUBLIC STREET).

8. Information from 21 towns. Compiled by A. H. Campbell, A.M. Inst. C.E., Canterbury. 1895.

9. Information from 54 towns. Compiled by C. C. Smith, Dalton-in-Furness. 1892.

48. *Information from various authorities. Compiled by E. J. Lovegrove, M. Inst. C.E., Hornsey. 1900.

LIQUID NIGHT SOIL (DISPOSAL OF).

38. *Information from various towns. Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.

PAVEMENTS (COMPARISON OF LIFE AND COST OF GRANITE AND GRITSTONE).

10. Information from 33 towns. Compiled by C. F. Wike, M. Inst. C.E., Sheffield. 1890.

PAVEMENTS (TAR MACADAM).

46. Information from various towns. Compiled by A. E. Collins, A.M. Inst. C.E., Norwich. 1896.

47. Information from various towns. Compiled by J. Hall, M. Inst. C.E., Cheltenham. 1896.

41. Information from 19 towns. Compiled by E. A. Stickland, A.M. Inst. C.E., Windsor. 1897.

PRIVATE STREET IMPROVEMENTS (CONSTRUCTION OF WORKS OF).

13. Information from 49 towns. Compiled by W. J. Newton, A.M. Inst. C.E., Accrington. 1892.

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Ref. No.

PUBLIC BATHS AND WASHHOUSES.

42. *Information from 44 towns. Compiled by P. Edinger, Frome. 1897.

REFUSE (COLLECTION OF).

14. Information from 89 towns. Compiled by J. Price, A.M. Inst. C.E., Toxteth Park. 1891.

REFUSE (DESTRUCTORS).

15. Information from 36 towns. Compiled by W. Brooke, A.M. Inst. C.E., Richmond. 1885.

33. Information from various towns and districts. Compiled by J. Gammage, Borough Surveyor, Dudley. 1899.

REFUSE (DISPOSAL OF).

16. Information from 39 towns. Compiled by J. Price, A.M. Inst. C.E., Toxteth Park. 1896.

REFUSE (REMOVAL OF).

17. Information from 87 towns. Compiled by C. R. Fortune, Bath. 1886.

ROADS (MAINTENANCE OF MAIN IN NON-COUNTY BOROUGHS).

18. Information from 83 towns. Compiled by W. Howard-Smith, A.M. Inst. C.E., Carlisle. 1894.

ROADS (PAVING OF MAIN).

31. Information from principal towns of Great Britain. Compiled by H. Richardson, A.M. Inst. C.E., Aston Manor. 1899.

ROADS (STEAM ROLLING OF).

19. Information from 42 towns. Compiled by A. W. Parry, A.M. Inst. C.E., Reading.

ROADS (WATERING OF).

20. Information from 65 towns. Compiled by W. Dawson, A.M. Inst. C.E., Leyton. 1891.

SCAVENGING (STREET).

17. Information from 87 towns. Compiled by C. R. Fortune, Bath. 1886.

SEWAGE (DISPOSAL OF).

21. Information from 53 towns. Compiled by J. H. Cox, M. Inst. C.E., Bradford. 1892.

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Ref. No.

SEWAGE (DISPOSAL OF).

22. Information from 41 towns. Compiled by H. Richardson A.M. Inst. C.E., Oldbury. 1890.

39. *Information from 172 towns. Compiled by J. W. Cockrill, M. Inst. C.E. 1900.

SEWAGE DISPOSAL WORKS.

35. *Information from various towns. Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.

SEWAGE (PURIFICATION OF).

22. Information from 41 towns. Compiled by H. Richardson, A.M. Inst. C.E., Oldbury. 1890.

SEWERS (VENTILATION OF).

23. Information from 81 towns. Compiled by J. T. Earnshaw, A.M. Inst. C.E., Ashton-under-Lyne. 1893.

SLAUGHTER-HOUSES.

25. Information from 22 towns. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth. 1885.

TRAMWAYS.

26. Information from 48 towns. Compiled by J. E. Swindlehurst, A.M. Inst. C.E., Burton-on-Trent. 1891.

TRAMWAYS (ELECTRIC).

24. *Information from various towns. Compiled by G. T. Lynam, A.M.Inst. C.E., Burton-on-Trent. 1903.

34. Information from various towns. Compiled by the Town Clerk of Birmingham. 1899.

43. Information from 34 American and Canadian towns. Compiled by Chas. Mayne, A.M. Inst. C.E., Municipal Engineer, Shanghai. 1897.

UNDERGROUND TELEPHONE AND TELEGRAPH WIRES.

37. *Information from various towns. Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.

WATER RATES.

44. Information from 25 (northern) towns. Compiled by A. W. Lawson, A.M. Inst. C.E., Borough Engineer, Rawtenstall. 1898.

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Ref. No.

WATER SUPPLY (DIAMETERS AND DEPTHS OF MAINS FROZEN IN 1895).

27. Information from 55 towns. Compiled by E. Pritchard, M. Inst. C.E., Birmingham. 1895.

WATER SUPPLY (FOR DOMESTIC AND GENERAL PURPOSES).

28. Information from 111 towns. Compiled by J. T. Eayrs, A.M. Inst. C.E., West Bromwich. 1890.

WORKMEN'S DWELLINGS.

29. *Information from 72 towns. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth. 1897.

WORKMEN'S WAGES AND HOURS OF LABOUR.

45. Information from various Metropolitan Public Bodies. Compiled by J. R. Dixon, A.M. Inst. C.E., Vestry Surveyor, St. Leonard, Shoreditch. 1897.

30. Information from 39 towns. Compiled by R. H. Haynes, Newport, Mon. 1897.

32. Information from various boroughs. Compiled by S. E. Burgess, M. Inst. C.E., South Shields. 1899.

TRANSACTIONS OF OTHER SOCIETIES, BOOKS, ETC.

London Chamber of Commerce. Report on Secret Commissions. 1899.

London Chamber of Commerce. Report on Cement Admixtures. 1897.

British Fire Prevention Committee.

Field Work and Instruments. By A. T. Walmisley.

Glasgow Congress, 1901.

Land Surveying and Levelling. By A. T. Walmisley.

Society of Engineers.

Stresses and Strains. By F. R. Farrow.

Structural Iron and Steel. By W. N. Twelvetrees.

The Sanitary Institute.

SPECIAL REPORTS.

Bacteriological Experiments with Sewage. Borough Surveyor, Leicester. 1900.

British Standard Sections. Engineering Standards Committee. 1903.

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Disposal of Refuse, etc., in Cities of Melbourne and Adelaide, Report on. City Surveyor, Sydney. 1891.

Manchester Main Drainage, Report on. City Surveyor, Manchester. 1896.

Motors for Municipal Purposes. Borough Engineer, Bermondsey. 1903.

Refuse Destructor and Electricity Works, Report on. Borough Engineer, Nelson. 1899.

Sewage Disposal, Report on. Borough Surveyor, Bradford.

Sewage Disposal Works, Specification, etc. for. Borough Engineer, Blackburn.

Sewage Purification. J. D. Watson. 1903.

Sewer Ventilation, Report on. Borough Engineer, Leicester. 1899.

Steam Road Rolling, Report on. County Surveyor, Hereford. 1897.

Storage of Flood Water. Prof. H. Robinson. 1899.

Town Refuse Destructors, Report on. Borough Surveyor of Ipswich. 1896.

Tramway Traction, Report on.

—— City Surveyor, Birmingham. 1899.

—— City Surveyor, Sheffield. 1897.

Treatment and Destruction of Refuse, Report on. City Surveyor, Sydney. 1897.

Western Australian Hard Woods. Agent-General for Western Australia. 1902.

Pamphlets.

Conical Projection of Maps. R. H. Foy. 1901.

Destructors and Steam Production. W. H. Maxwell. 1901.

Formulæ and Tables of Velocities and Discharges of Sewers. T. De Courcy Meade. 1897.

Hodograph, the. T. Ferguson. 1901.

Incrustation of Iron Water Pipes. Water Engineer, Torquay.

Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions for 1902. Compiled by A. Brown, M. Inst. C.E., Borough Surveyor, Nottingham, and Philip Boobbyer, M.B.

Presidential Address to Association of Birmingham Students. J. Price. 1902.

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Raising of Water from Deep Wells by Compressed Air. W. H. Maxwell. 1903.

Type Drawings for Melbourne Sewerage. W. Thwaites, Chief Engineer, Melbourne.

Drawings of Lot's Road Pumping Station, L.C.C. Maurice Fitzmaurice, Chief Engineer.

JOURNALS.

American Electrician.
" Electrical World and Engineer.
" Engineering Record.
Builder.
Contract Journal.
Electrical Engineer.
Local Government Chronicle.
Public Health Engineer.
Street Railway Journal.
Surveyor and Municipal and County Engineer (from vol. iv.).
Water.

PAPERS.

A few prints of the following Papers (contained in past Volumes of 'Proceedings') are in stock at the Offices of the Association, and may be obtained from the Secretary, *if the* **Reference Number** *is quoted and an addressed postal wrapper is enclosed for each paper required.*

98. Aberdeen, Municipal Engineering in. W. Dyack.
97. Aberdeen Waterworks. J. Gordon.
2. An English Municipal Engineer's Visit to America. G. Livingstone.
4. Bacterial Treatment of Sewage. G. Thudichum.
8. Bristol, Municipal Progress in. T. H. Yabbicom.
28. Bristol Tramways Electrical Installation. J. Clifton Robinson.
40. Building Bye-laws, Position of Local Authorities in regard to. F. C. Cook.
6. Bute Docks, Notes on. C. L. Hunter.
7. Cable Traction, Conversion of Edinburgh Horse Tramway System into. W. N. Colam.
10. Carlisle Electric Lighting. C. D. Burnet.
12. Carlisle, Public Works of. H. C. Marks.
90. Chichester, Municipal Engineering Works in. James Saunders.

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86. Coal-Mining Subsidences in Relation to Sewerage Works. F. W. Mager.
16. Continuous Sewage Filter, Construction of. F. Wallis Stoddart.
17. Deal, Municipal Works in. T. C. Golder.
11. Drainage, London House. L.C.C. Bye-Laws. W. Weaver.
21. East Molesey, Public Works in. J. Stevenson.
29. Electrical Works in Bristol. H. Faraday Proctor.
96. Electric Cable Subway. G. R. G. Conway.
108. Electric Lighting, Sunderland. J. C. Snell.
15. Electric Wiring Practice. F. Bathurst.
41. Fergusson's Surveying Circle and Percentage Unit of Angular Measurement. John C. Fergusson.
46. Filtration of River Water. Alfred J. Jenkins.
24. Floods Prevention Works in Bristol. W. J. Steele.
20. Hard Wood Paving, Wear and Weight of Traffic on. W. N. Blair.
22. Hard Wood Pavements in Sydney. R. W. Richards.
39. Hastings Water Supply. P. H. Palmer.
23. Hospital Tents. C. H. Cooper.
88. Housing of the Labouring Classes. A. H. Campbell.
110. Housing of the Working Classes. R. S. Roundthwaite.
26. Infectious Diseases Hospital at Ham Green. Herbert W. Harding.
25. Kent Main Roads. F. W. Ruck.
1. King's Lynn Municipal Works. Henry James Weaver.
27. Light Railways. H. T. Wakelam.
33. Londonderry, Engineering Progress of. W. J. Robinson.
19. Macadam Road Construction, Analysis of. C. H. W. Biggs.
36. Main Roads under County Councils in Ireland R. H. Dorman.
80. Methods of Safety for the Overhead Electric Trolley System. Edward Manville.
18. Motor Vehicles for Borough and County Work. E. Manville.
83. Municipal Sanitation. William Weaver.
54. Newbury Municipal Work. S. J. L. Vincent.
93. Oswestry, Municipal Work in. G. William Lacey.

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94. **Passenger Lift, East Hill, Water Balance.** P. H. Palmer.
44. **Power Houses, On the abuse of.** Sir W. H. Preece, K.C.B., F.R.S.
31. **Purification of Sewage by Land.** H. Royle.
35. **Rainfall, Rate of.** J. P. Dalton.
50. **Restoration of Municipal Buildings.** H. A. Cutler.
85. **Rifle Ranges and their Public Provision.** J. W. Bradley.
100. **Runcorn, Municipal Work in.** J. Wilding.
79. **Sewage Purification at Huddersfield by Bacterial and other Methods.** K. F. Campbell.
81. **Sewage Treatment.** Lieut.-Colonel A. S. Jones, *V.C.*
113. **Sewer Ventilation.** T. Caink.
47. **Sewerage and Sewage Disposal Works.** J. Kemp.
34. **Shipley Municipal Works.** I. Lindow.
91. **Southend-on-Sea, The Municipal Works of.** Alfred Fidler.
109. **Specifications of Roads.** H. W. Taylor.
104. **Sudbury, Municipal Work at.** T. W. A. Hayward.
65. **Sunderland Electric Lighting.** J. C. Snell.
89. **Swadlincote Public Works.** Thomas Kidd.
49. **Tonbridge, Municipal Work in.** W. L. Bradley.
14. **Tramways, Wear and Maintenance of.** C. F. Wike.
95. **Tramway Track Construction.** J. T. Anderson.
105. **Ventilation of Drains.** C. C. Smith.
111. **Ventilation of Sewers.** A. W. Cross.
106. **Ventilation of Sewers.** H. H. Humphries.
112. **Ventilation of Sewers.** R. Read.
107. **Ventilation of Sewers.** W. J. Steele.
103. **Water Supplies.** R. Pickering.
102. **Whitehaven, Public Works of.** J. S. Brodie.
99. **Widnes Corporation Gas and Water Works.** J. Carr.
101. **Widnes, Municipal Works of.** J. S. Sinclair.
72. **Wimbledon, Electric Lighting Scheme.** A. H. Preece.
73. **Wimbledon, Municipal Work.** C. H. Cooper.
42. **Wolverhampton Corporation Tramways Electrical Equipment.** C. E. C. Shawfield.
43. **Wolverhampton Corporation Electric Tramways, 1902.** George Green.

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VOLUNTARY EXAMINATIONS.

SYLLABUS.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS undertake the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council and duly advertised beforehand.

The Council will consider, and, if desirable, accept applications to sit at these Examinations, in order of priority, as far as accommodation permits, but reserve the right of returning, or transferring any application to an Examination to be held on any subsequent date, in which case due notice will be given.

The Examinations are by written papers and *viva voce*, upon the four following subjects:—

Engineering as applied to Municipal work.
Building Construction and Materials.
Sanitary Science as applied to Towns and Buildings.
Municipal and Local Government Law as relating to the work of Municipal Engineers and Surveyors.

Candidates are not necessarily required to answer all the questions set in each paper: marks are given for all questions correctly answered. Where the subject is sub-divided, at least one question should be attempted in each sub-section.

The Examinations occupy three days, and the arrangements are as follows:—

First day,	10 to 1 ..	..	Sanitary Science.
„	2.30 to 6.30	..	Building Construction.
Second day,	10 to 1 ..	..	Municipal and Local Government Law.
„	2.30 to 6.30	..	Engineering.
Third day,	10 ..	..	*Viva voce* Examination.

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Fifty per cent. of the total number of marks given are required to constitute a pass.

Intending candidates who have not previously applied for permission to sit, must do so on the form issued with the syllabus.

If permission is granted by the Council, a "sitting" form will be forwarded. The candidate may then make application on such form to sit at the next ensuing, or at any future, examination.

Candidates who have sat and failed, or who have applied for and received permission to sit, are particularly requested to ask for a "sitting" form, when they desire to present themselves for examination.

The fee is to be sent with the sitting form ONLY.

Candidates must have attained their twenty-second birthday.

The fee for each Examination is 4*l.* 4*s.*, two guineas to be paid with the "sitting" form, and the balance on the day of examination. Should the candidate fail, he is entitled to present himself at any subsequent Examination, on payment of 2*l.* 2*s.*, one guinea to be paid on application and one guinea on the day of Examination.

Candidates who sat and failed at any of the Examinations held prior to and including April 1898, pay 1*l.* 1*s.* entrance, and 10*s.* 6*d.* sitting fees.

No further charge is made to the candidate than the fees above mentioned.

Candidates who do not present themselves for examination forfeit their entrance fee.

Successful candidates receive a Certificate in the form of a 'Testamur," signed by the acting Examiners, and sealed and countersigned by the President and Secretary of the Association in Council.

No information as to the result of an Examination, beyond the fact of a candidate having "Passed" or "Failed," is given.

Questions set at Examinations held prior to 1902 can only be obtained in the volumes of the 'Proceedings.' On sale by Messrs. E. & F. N. SPON, Ltd., Publishers, 125 Strand, W.C. The questions set at subsequent examinations are not published.

No exemption from any portion of the Examination is granted to candidates.

Any inquiries referring to the Examinations should be directed to Mr. THOMAS COLE, Secretary to the Association, 11 Victoria Street, London, S.W., and should be accompanied by an addressed foolscap envelope.

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SUBJECTS OF EXAMINATION.

I.—ENGINEERING AS APPLIED TO MUNICIPAL WORK:

A. Surveying and Levelling.
B. Hydraulics.
C. Sewerage and Sewage Disposal.
D. Water Supply.
E. Road Making, including Tramways and Bridges.

II.—BUILDING CONSTRUCTION: STRENGTH OF MATERIALS:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.
D. Public Baths and Hospitals.

III.—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS:

A. Heating and Ventilation.
B. Scavenging and Disposal of Refuse.
C. Water Supply and Drainage of Buildings.
D. Disinfection.

IV.—MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

NOTE.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following questions have been compiled from Examination Papers set to Candidates, and serve as examples of the questions asked under the different sections.

DIRECTIONS.—You are particularly requested to write legibly, and to answer the questions as concisely as possible. *Put your number at the top of every book and question paper handed in.* Prefix the number of the question to each answer. Where the subject is subdivided, at least one question should be attempted in each subsection. Wherever possible, freehand sketches or diagrams should be drawn to illustrate the answer; these should be carefully executed, as they will be taken as showing the candidate's proficiency in this style of drawing. Candidates must not, during the examination, refer to any books or manuscript, nor communicate with each other.

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SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

A. SURVEYING AND LEVELLING.

1. It is desired to range a straight line joining two fixed points, neither of which is visible from the other because of the intervention of a fold in the land: both ends can be seen from anywhere along the central half of the line: show how you would range this line.
2. (*a*) Describe contour lines and their object.
   (*b*) State how the positions of contour lines are determined.

B. HYDRAULICS.

1. Explain the terms "hydraulic mean depth" and "wetted perimeter," and their relation to each other.
2. What are considered self-cleansing velocities in sewers of small and large diameters respectively? When does a circular pipe discharge its greatest volume?

C. SEWAGE AND SEWAGE DISPOSAL.

1. State the nature and proportions of the materials for a concrete sewer, and the test you would apply to secure strength.
2. Describe the system of purifying sewage by means of an open septic tank and contact beds, and the principal parts of the works required for dealing with the sewage.

D. WATER SUPPLY.

1. Draw a cross section of an embankment 50 feet high to an open reservoir, showing a puddle wall; and figure the inside and outside slope.
2. Give a description of the different methods of gauging the flow of water and the formulæ used in connection therewith.
3. Give amount of water required per head per day in a town of 20,000 persons, purely residential, and divide the quantity under the usual heads.

E. ROAD-MAKING, INCLUDING TRAMWAYS AND BRIDGES.

1. Sketch a cross-section of a 50-foot road, including paved side-paths, showing cross falls and method of formation, and furnish short description of materials to be used.
2. Describe briefly each system of mechanical traction in use on street tramways in this country, and state the advantages or disadvantages of each.
3. For a carriage-road wrought-iron girder bridge, say of 200 feet span and 40 feet wide over all, state the live and dead load, about, to be provided for.

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SUBJECT:—BUILDING CONSTRUCTION.

A. MATERIALS.

1. What descriptions of timber are best suited for the construction of outside work? Name them in order of merit.
2. Write a specification of good hair mortar.
3. Give the proper thicknesses of sheet lead in lbs. per square foot used on roofs in various parts, giving the trade terms.

B. THE CONSTRUCTION OF PUBLIC AND PRIVATE BUILDINGS.

1. What is meant by a "king post" and a "queen post" principal? Make a sketch of each, with scantlings, applied to spans of 25 feet and 50 feet respectively, and state distances between the principals.
2. What proportions of cement, sand and broken brick or stone would you specify for concrete for
   (*a*) Foundations for main walls.
   (*b*) Concrete stair landings.
   (*c*) Water-tight work.
3. Draw a figured section of a wrought-iron girder over a shop, 20 feet clear span, to carry front wall of house, two stories, 23 feet total height, and the floor joists of two rooms, the thickness of the wall to be 1½ brick.

C. BUILDING BYE-LAWS.

1. State the means of ventilation required to be provided for a "habitable room without a fire-place."
2. What proportion do the "Model Bye-Laws" prescribe for the open space in rear of a dwelling, and how to be measured?
3. State generally the requirements of these bye-laws as to—
   (*a*) The levels, widths and construction of new streets.
   (*b*) The construction of water-closets in a building.

D. PUBLIC BATHS AND HOSPITALS.

1. Give sketches and descriptions of a covered swimming-bath pond, and of the heating and overflow arrangements thereof.
2. In case of a temporary hospital for immediate requirements, give sketch plan showing position of closets, bath, nurses' room and administrative departments.

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Subject:—SANITARY SCIENCE as Applied to Towns and Buildings.

A. Heating and Ventilation.

1. How would you warm and ventilate a ward in an infectious diseases hospital?
2. Describe various methods of ventilating sewers, and give opinions as to the merits or otherwise of the same.
3. Describe the system you would employ for ventilating a theatre of average size, assuming your own conditions.

B. Scavenging and Disposal of Refuse.

1. Describe, so far as house refuse is concerned, the best mode of collection.
2. How many cells would you specify in a refuse destructor for a population of 40,000 in a residential town?
3. Give a short description of the "conservancy" systems of disposal of town's refuse, and the advantages or disadvantages of each system.

C. Water Supply and Drainage of Buildings.

1. State the advantages of soft water and of hard, comparatively.
2. A dwelling house is to be erected on damp subsoil; describe in detail the necessary works to render it dry and healthy.
3. What gradient would be necessary in 4, 6 and 9-inch pipe to ensure self-cleansing?

D. Disinfection.

1. Describe a disinfecting station suitable for a town of 40,000 population, noticing the special points, and giving the principal dimensions. Give an approximate estimate of cost excluding land, stating cost of 9-inch brickwork per square yard.
2. Describe various forms of disinfecting apparatus.
3. What method would you adopt to prevent the spread of infectious disease which has broken out in a crowded portion of the district?

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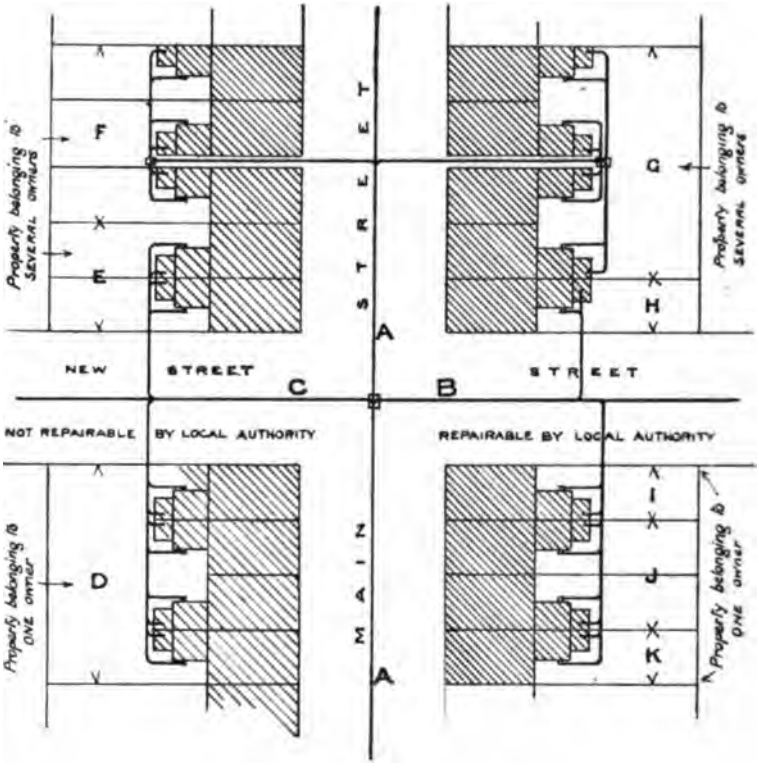
SUBJECT:—MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

1. Mark on the accompanying plan which are "sewers" and which are "drains" in connection with the streets A, B and C, and the properties D to K respectively, giving the grounds upon which you base your conclusions.



2. State the provisions of the Public Health Acts Amendment Act, 1890, with respect to "Sanitary Conveniences for manufactories." What number of water-closets should you consider sufficient for (*a*) 100 males; (*b*) 100 females?

3. Specify the duty of a local authority with respect to (*a*) nuisances; (*b*) epidemics.

4. Give a short outline of Act for Housing of the Working Classes, and the responsibility of a local authority where the same has been adopted.

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5. Describe the differences in the execution of the work and in making on the apportionment of cost in the event of the Private Streets Act, 1892 having been adopted by the authority.
6. An urban authority desires to widen and improve a public street. State the different methods of proceeding. Name the various Acts and clauses.
7. What are the regulations prescribed in the Tramways Act, 1870, with regard to opening, breaking up and altering the level of roads by a tramway company for the purpose of making, maintaining and renewing a duly authorised tramway?
8. What is the meaning of the term "main road," used in the Local Government (England and Wales) Act, 1888, and in the Highways and Locomotives (Amendment) Act, 1878?
9. What steps must a local authority take before commencing sewerage or sewage works without their district?
10. In what manner, and under what Act, may ruinous or dangerous buildings be dealt with?

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38th Examination, October 1902.

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D. P. Howells.
J. R. Heath.
F. W. Jones.
H. G. Marrian.
H. A. Newman.
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S. G. Turner.
W. Withers.

39th Examination, April 1903.

F. T. Ecroyd.
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W. Hutton.
R. R. Knight.
W. Ord.
O. B. Rattenbury.
E. Y. Saunders.
H. E. Tasman.

40th Examination, April 1903.

H. L. Butler.
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H. L. Stevens.
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41st Examination, April 1903.

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S. F. R. Carter.
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T. Jones.
F. W. Knewstubb.
J. J. Knewstubb.
G. P. Knowles.
F. O. C. Nash.
L. Roseveare.
F. P. Sissons.

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Memoirs of Deceased Members.

The Council having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

Mr. F. BALL, late Borough Surveyor, Southwold, died on the 11th May, 1903. He was elected a Member on the 17th December, 1898.

Mr. J. MYATT, late Town Surveyor, Leek, died on the 5th February, 1903. He was elected a Member on the 12th June, 1886.

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